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Early Miocene mammals from the Lemhi Valley of Idaho

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EARLY MIOCENE MAMMALS FROM THE LEMHI VALLEY OF IDAHO

By

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ABSTRACT

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Early Miocene Mammals from the Lemhi Valley of Idaho

Director: Robert W. Fields

The first fauna to be described from an early Miocene locality in the Lemhi Valley of east-central Idaho contains two new aplodontids, Meniscomys yeariani and Meniscomys petersoni; the upper dentition of the aplodontid Niglarodon; skull fragments and associated upper and lower dentition of a new mylagaulid, Promylagaulus lemhiensis; two new primitive geomyids, Entoptychus fieldsi and Entoptychus sheppardi; and the associated upper and lower dentition of the cricetid Paciculus insolitus. Other mammals are the soricid Domnina; a scuirid; the ochotonid Oreolagus; a procyonid; three oreodonts, Megoreodon grandis, Mesoreodon chelonyx, and a small species; an equid, Miohippus cf. gemmarosae; and a rhinocerid. A trend toward increasing hypsodonty is evident in the two species of Meniscomys. The age of the beds would conform, in part, to the Meniscomys Concurrent-range Zone and lower part of the "Entoptychus-Gregorymys" Concurrent-range Zone of the John Day Formation of Oregon. This is equivalent to the upper Sharps and Monroe Creek formations of South Dakota, which are middle Arikareean (early Miocene). The Peterson Creek Local Fauna has genera in common with both the John Day and South Dakota faunas, but is more closely allied to the faunas of the nearby intermontane basins of Montana.

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INTRODUCTION

The Lemhi Valley of east-central Idaho lies west of the continental divide and is drained by the Lemhi River, a northwest flowing upper tributary of the Columbia River system. Tertiary exposures are common throughout the seventy-five mile length of the valley. They range in age from Paleocene or Eocene (Anderson, 1959, p. 21) north of the Lemhi's confluence with the Salmon River, through questionably Late Oligocene (Anderson, 1957, p. 16) as one proceeds upriver, to early Miocene at Peterson Creek, late Miocene at Mollie Gulch and Pliocene at the Lemhi's headwaters in the vicinity of Gilmore (Text - fig. 1). These youngest sediments have been tentatively dated by a small collection of vertebrates containing Dipoides sp. made by a field party from the University of Montana in 1973.

Peterson Creek, intermittent in its lower reaches, flows for about seven miles from the continental divide southwestward and empties into the Lemhi River forty miles upriver from the town of Salmon. I found fossil bones on Peterson Creek in 1936 and continued to collect for several years thereafter. In 1941, Dr. John A. Wilson and an assistant from the University of Idaho at Moscow spent the summer collecting in the valley (Wilson, 1946, p. 1262). From 1959 through 1961 Dr. Lawrence P. Richards of Idaho State University at Pocatello camped at Peterson Creek and collected in the region. Dr. J. Leroy Kay visited the area and took back specimens to the Carnegie Museum at Pittsburgh, Pennsylvania. Starting in 1970, I have added to my original collection, all of which material is now deposited in the Museum of Paleontology at the University of Montana at Missoula.

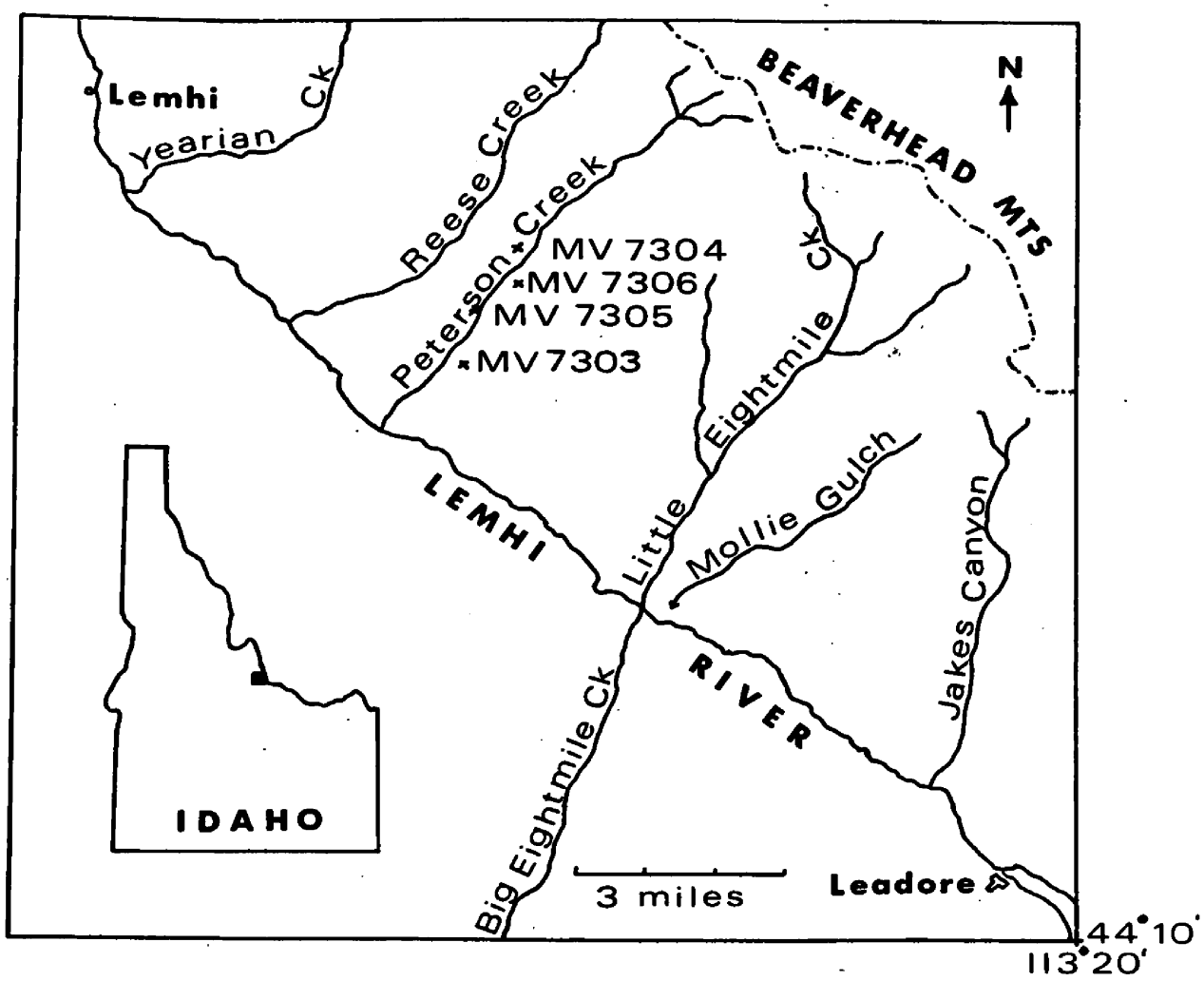
Late Miocene vertebrates from strata overlying the Peterson Creek beds are to be described in a study now in progress. That study includes the geology and the stratigraphic relations of this area and adjoining parts of Montana.

ACKNOWLEDGMENTS

I wish to thank Dr. John A. Wilson, Dr. Lawrence P. Richards and Dr. John A. White for making material available to me for study, Dr. John M. Rensberger and Dr. Thomas H. Patton for their criticism and advice, Dr. Don W. Rasmussen for his help and cooperation, Dr. Edward T. Ruppel for prompting me to begin this study, and Dr. Robert W. Fields of the University of Montana, for his instruction and encouragement.

ABBREVIATIONS

AMNH	American Museum of Natural History, New York
CM	Carnegie Museum, Pittsburgh
FM	Field Museum of Natural History, Chicago
ISU	Idaho State University, Pocatello
MV	University of Montana vertebrate locality
PU	Princeton University, New Jersey
SDSM	South Dakota School of Mines, Rapid City
UCMP	University of California, Berkeley
UM	University of Montana, Missoula
UT	University of Texas, Austin
YPM	Yale Peabody Museum, New Haven



Text-fig. 1. Area map of a mid-portion of Lemhi Valley showing location of University of Montana vertebrate localities.

GEOLOGIC SETTING

The Peterson Creek beds are best exposed on the southeast side of Peterson Creek and extend for about two miles through sections 9, 16, 17 and 20 and appear on the northwest side of the creek in sections 8 and 17, T 17 N, R 25 E, Lemhi County, Idaho. University of Montana localities are MV 7303 which consists of three prominent exposures on the southeast side of the creek. The northernmost of these which was named Rodent Wash by Richards in his field notes (on deposit at Idaho State Museum, Pocatello), is partly in the SW¼SE¼ of Sec. 20 and the NW¼NW¼ of Sec. 17 (Text-fig. 1). The beds of this exposure overlie those of the next exposure to the southwest which was called Big Wash by Richards and is mostly in the NW¼NW¼ Sec. 17. The southwestern exposure in the NW¼SW¼ Sec. 17 Richards called "Nichols Site" but I shall refer to it as South Bluff (Text-fig. 2). The Idaho State University locality number corresponding to MV 7303 is ISU 59003. MV 7304 is in the SE¼SE¼ Sec. 8, MV 7305 is in the SE¼NW¼ Sec. 17. All of the above localities are in the Lemhi, Idaho, quadrangle. MV 7306 lies at the edge of a large landslide, but it was not determined if the actual locality had moved. There some microfossils were screened from an anthill, and they indicate a stratigraphic position equivalent to the lower part of the exposure at Big Wash. The stratigraphic position of MV 7304 and MV 7305 on the northwest side of Peterson Creek was not determined with relation to MV 7303.

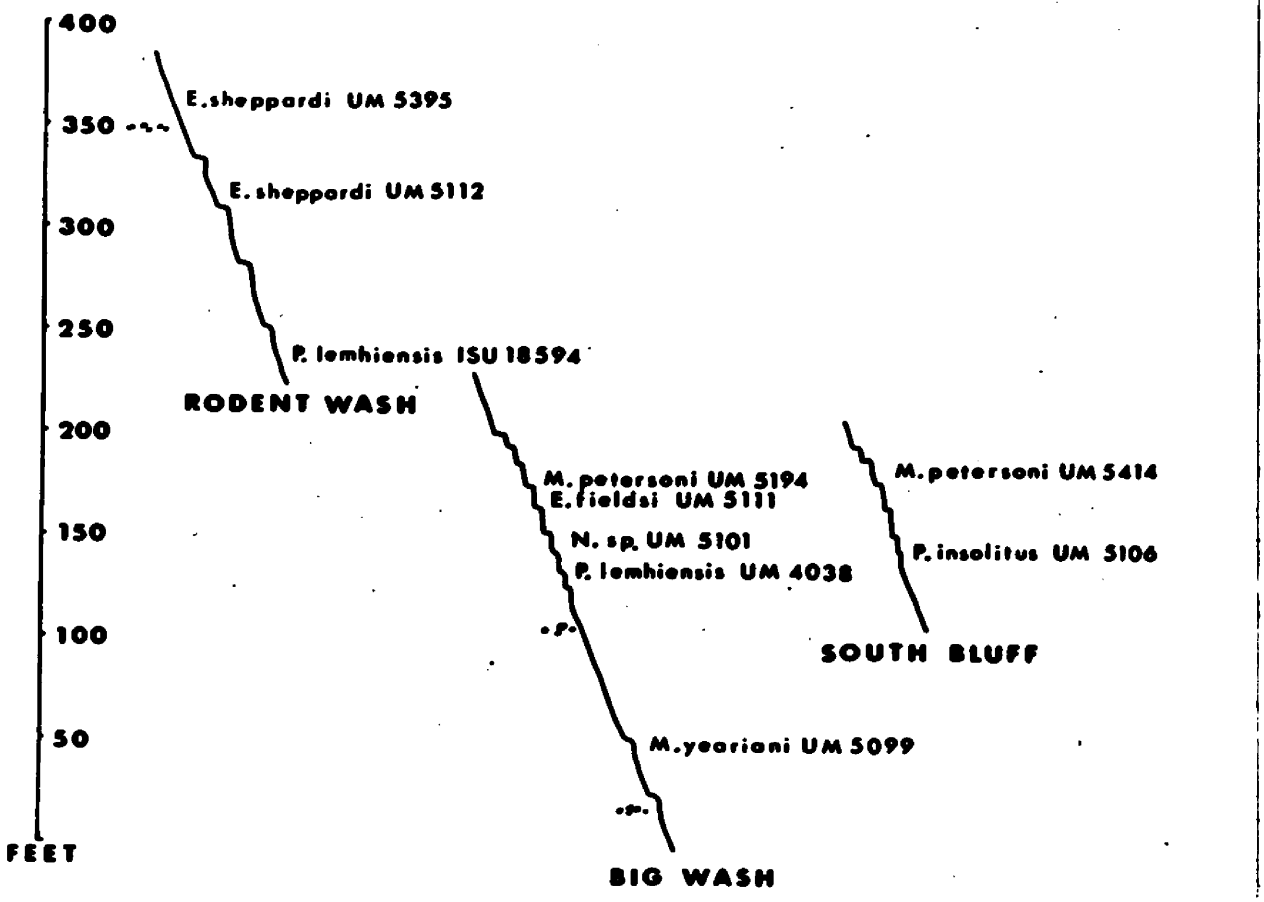
The exposures are located on federally owned land administered

by the Bureau of Land Management in Salmon, Idaho, and surround the Peterson Creek Ranch owned by George Ellsworth of Lemhi, Idaho.

The base of the beds was not observed, but the exposed thickness measures nearly 400 feet. The beds are composed of buff-colored tuffaceous sediments with occasional layers of water-laid gray volcanic ash. A few fluviatile conglomerates of small pebbles are present. There is one stream channel with large cobbles up to 10 inches in diameter. In general, the sedimentation is representative of low-flow regime floodplains. Scoria and volcanic material in the conglomerates probably originated from the Yearian Volcanics (Anderson, 1961, p. 48) to the north on Reese Creek and indicate a former drainage to the southeast as opposed to the present northwest drainage of the Lemhi River. The beds are gently deformed but with dips up to 35 degrees locally.

AGE

Umpleby in 1913 (p. 35) first described the valley fill as "Miocene lake beds". Wilson (1946, p. 1262) stated that the age of the fossil-bearing beds in the Lemhi Valley might be as young as Pliocene or as old as early Miocene. Anderson (1961, p. 33) mapped the geology of the Lemhi quadrangle and correlated the beds at Peterson Creek with those he called the Geertson Formation about thirty miles downriver in the Baker quadrangle and gave the age of both as middle Miocene. No vertebrates are known from the type locality of the Geertson Formation and, as the beds are not traceable into the fossil



Text-fig. 2. Diagramatic slope profiles of exposures at MV 7303 showing stratigraphic occurrence of Entoptychus, Meniscomys, Niglarodon, Paciculus insolitus and Promylagaulus lemhiensis.

bearing deposits, I cannot confirm this correlation.

Following is a faunal list from the Peterson Creek beds:

Soricidae

Domnina sp. indet.

Ochotonidae

Oreolagus sp. indet.

Sciuridae

Sciurid *gen. et sp. indet.*

Aplodontidae

Meniscomys yeariani sp. nov.

Meniscomys petersoni sp. nov.

Niglarodon sp. indet.

Promylagaulus lemhiensis sp. nov.

Geomyidae

Entoptychus fieldsi sp. nov.

Entoptychus sheppardi sp. nov.

Cricetidae

Paciculus insolitus

Procyonidae

Procyonid *gen. et sp. indet.*

Merycoidodontidae

Megoreodon grandis

Mesoreodon chelonyx

Oreodont *gen. et sp. indet.*

Equidae

Miohippus cf. *gemmarosae*

Rhinocerotidae

Rhinocerid *gen. et sp. indet.*

The presence of *Meniscomys* indicates a correlation with the *Meniscomys* Concurrent-range Zone of Fisher and Rensberger (1972, p. 23) in the upper part of the John Day Formation of Oregon. There *Meniscomys* occurs in the upper part of the Turtle Cove Member and lower part of the Kimberley Member. The boundary between the two is not a time equivalent marker (Text-fig. 3). Other genera in common with the John Day Formation are *Paciculus*, *Megoreodon* (*Promerycochoerus*), and *Miohippus*.

Meniscomys is present in the Wounded Knee area of South Dakota, in the lower part of the Monroe Creek Formation and the upper part of the Sharps Formation (ibid. p. 27). Other genera from South Dakota reported by Macdonald (1970, p. 8) in common with Peterson Creek are *Promylagaulus*, *Paciculus*, *Miohippus*, *Megoreodon* and *Mesoreodon*.

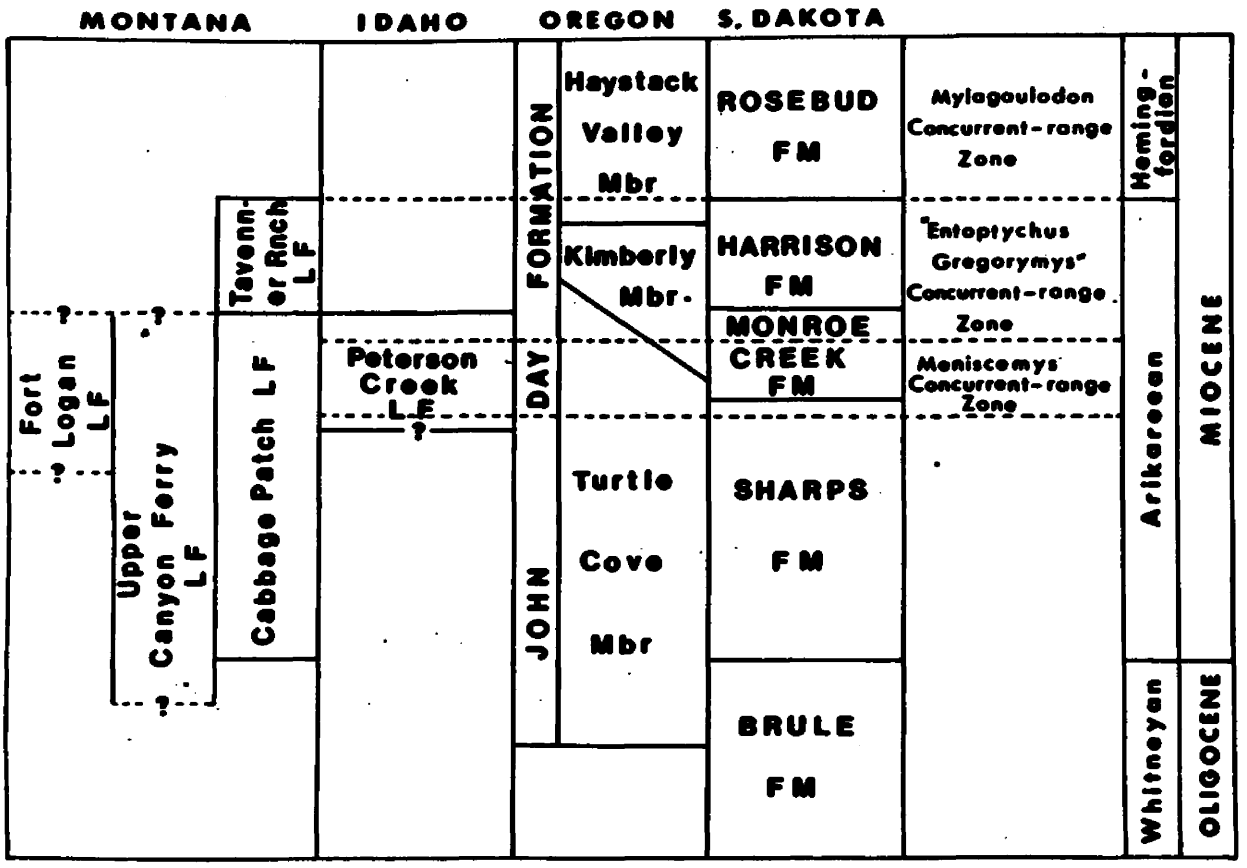
All of the genera from Peterson Creek have been reported from the intermontane basins of Montana with the exception of *Promylagaulus* and *Meniscomys* but Rasmussen has found *Meniscomys* in the Deer Lodge Valley (personal communication, 1975). Several species, *Megoreodon grandis*, *Mesoreodon chelonyx*, *Miohippus* cf. *gemmarosae* and the only other reported specimen of *Niglarodon* (from the Fort Logan Formation of Montana) demonstrated close affinities between the Peterson Creek fauna and the faunas of the intermontane basins of Montana.

The Peterson Creek fauna yields the only Promylagaulus known from Idaho and Montana.

The lower beds containing the primitive Meniscomys yeariani are equivalent to the lower part of the Meniscomys Concurrent-range Zone. The horizon with the more advanced Meniscomys petersoni and the primitive entoptychine Entoptychus fieldsi may be equal to the top of the Meniscomys Concurrent-range Zone. The presence of Entoptychus in the Meniscomys zone is not compatable with the condition in the John Day region where Entoptychus occurs higher in the section, but E. fieldsi is of such a primitive nature that it could be close to the origin of the entoptychine lineage and may occur earlier in Idaho than in Oregon.

Entoptychus sheppardi in the upper Peterson Creek beds is slightly more primitive than the most primitive form from the John Day, E. basilaris, which would indicate that these beds would be equivalent to or slightly earlier than the base of the "Entoptychus-Gregorymys" Concurrent-range Zone of the John Day.

The beds at Peterson Creek would be equivalent to the upper Sharps and Monroe Creek formations of South Dakota which are middle Arikareean (early Miocene) (Text-fig. 3).



Text-fig. 3. Correlation chart of Arikareean faunas and formations showing relative position of the Peterson Creek Local Fauna.

Order INSECTIVORA Bowdich, 1821

Superfamily Soricoidea Gill, 1872

Family SORICIDAE Gray, 1821

Subfamily HETEROSORICINAE Viret and Zapfe, 1951

DOMNINA Cope, 1873

Type species.---Domnina gradata Cope, 1873.

Distribution.---Oligocene to early Miocene of North America.

Generic description---M_1 low cusped; reentrant valley between protoconid and hypoconid opens at level of cingulum; M_1 has prominent entoconid distinctly separated from hypolophid and united to metaconid by high ridge (entoconid crest); teeth not bulbous; cingulum strong but not inflated.

DOMNINA sp. indet.

PLATE 1, Figs. 1 & 2

Material.---UM 4042, fragment of right ramus with M_2, from MV 7306.

Description.---This form is considerably smaller than the type of D. gradata. It is low cusped with the reentrant valley between the protoconid and hypoconid opening at the level of the cingulum. The entoconid crest is high posteriorly and separated from the hypolophid, but unlike the usual condition, it is worn down at its point of juncture with the metaconid. The labial cingulum extends from the paraconid around the protoconid to the hypoconid. The teeth are heavily

pigmented and the reddish-brown color extends from the crest of the protoconid down the anterior face of the tooth to the cingulum. The crests of the entoconid and hypoconid are also stained. The antero-posterior length of the M_2 is 1.36 mm and the traverse width is 0.96 mm. (Terminology from Repenning, 1967, p. 9).

This specimen is not complete enough to permit species designation because it lacks diagnostic premolars, angle and condyle of the jaw.

Order LAGOMORPHA Brandt, 1855

Family OCHOTONIDAE Thomas, 1897

OREOLAGUS Dice, 1917

Type species.---Oreolagus nevadensis (Kellogg), 1910.

Paleolagus nevadensis Kellogg, 1910.

Distribution.---Miocene, Arikareean to Barstovian of Nebraska, Colorado, Wyoming, Nevada, Oregon and Idaho.

Generic description.---Cheek teeth hypsodont; M_2 composed of trigonid and slightly narrower or equally wide talonid; talonid has narrow anterior protrusion; column of each tooth joined by cement. Dental formula $\frac{(2)}{1}\ \frac{0}{0}\ \frac{3}{2}\ \frac{2}{2}$.

OREOLAGUS sp. indet.

PLATE 2, Fig. 4

Material.---UM 4060, lower cheek tooth from MV 7306.

Description.---The generic characters are those of Oreolagus but species determination was not possible from a single tooth. (Anteroposterior length 1.59 mm, transverse width of the trigonid 1.36 mm, and transverse width of talonid 1.34 mm.)

Order RODENTIA Bowdich, 1821

Suborder SCIUROMORPHA Brandt, 1855

Family SCIURIDAE Gray, 1821

Subfamily SCIURINAE Baird, 1857

SCIURID gen. et sp. indet.

PLATE 1, Figs. 3 & 4

Material.---UM 4043, M_2 or M_3 and UM 4054, M_2 or M_3 both from MV 7306.

Description.---In these two small low-crowned lower molars the trigonids are slightly elevated above the talonids. Their shape is rhomboidal with the lingual halves shorter. Protoconids, anteroconids, metaconids, entoconids and hypoconids are distinct as are the mesostylids and mesoconids. (Terminology from Black, 1963, p. 121.) The metaconid is high and prominent. The entoconid corner is rounded and the entoconid merges into a low hypolophid extending to the hypoconid. The ectolophid is set back from the buccal margin and strongly indented by a buccal valley which is dammed by a distinct mesoconid.

In UM 4054 (Pl. 1, Fig. 3) a metalophid connects the protoconid and metaconid and forms the posterior border of the trigonid. The trigonid opens at the anterolabial corner of the tooth and separates the protoconid from the anteroconid. There is a deep cleft between the mesostylid and the entoconid and a minor constriction separates the mesostylid from the metaconid. (Anteroposterior length 1.98 mm, transverse width 2.04 mm across the trigonid and 2.15 mm across the talonid.)

UM 4043 (Pl. 1, Fig. 4) lacks the deep cleft separating the mesostylid from the entoconid. The mesostylid is set apart from the metaconid and the entoconid by shallow valleys which indent the lingual surface of the tooth. The trigonid is not completely enclosed posteriorly as the metalophid is incomplete and does not join the metaconid. (Anteroposterior length 2.21 mm, transverse width across the trigonid 2.07 mm and 2.17 mm across the talonid.)

Family APLODONTIDAE Trouessart, 1897

MENISCOMYS Cope, 1879

Type species.---Meniscomys hippodus, AMNH 6964, from the John Day Formation of Oregon.

Included species.---Type plus M. milleri Macdonald, M. yeariani sp. nov. and M. petersoni sp. nov..

Distribution.---Early Miocene, Arikareean of the John Day region of Oregon, South Dakota and Idaho.

Generic description (revised).---Dentition $\frac{1}{1}\frac{0}{0}\frac{2}{1}\frac{3}{3}$. Molars hypsodont with short roots. P^4 with three external crescents and one internal crescent; parastyle and mesostyle present; four or five lakes present in worn tooth, hypoflexus may constrict with wear to form parafossette (fifth lake) and by closure posterad forms hypofossette. Upper molars with four or five lakes; mesostyles and metastyles present.

P_4 with anteroflexid; protoflexid and hypoflexid with common opening on labial side; paraflexid and mesoflexid present on lingual side. Unworn lower molars with curved transverse crests connected longitudinally on the median line; lateral emarginations on each side of tooth, becoming shallower with wear and finally disappearing entirely from the lingual side in advanced stage of wear. (Text-fig. 4 C & D, nomenclature of dentition.)

MENISCOMYS YEARIAN sp. nov.

PLATE 2, Figs. 5, 6 & 8 Text-figs. 4, 5, 6, Table 1

Type.---UM 5099, maxilla with RP^3 - M^2, LP^3 - M^1.

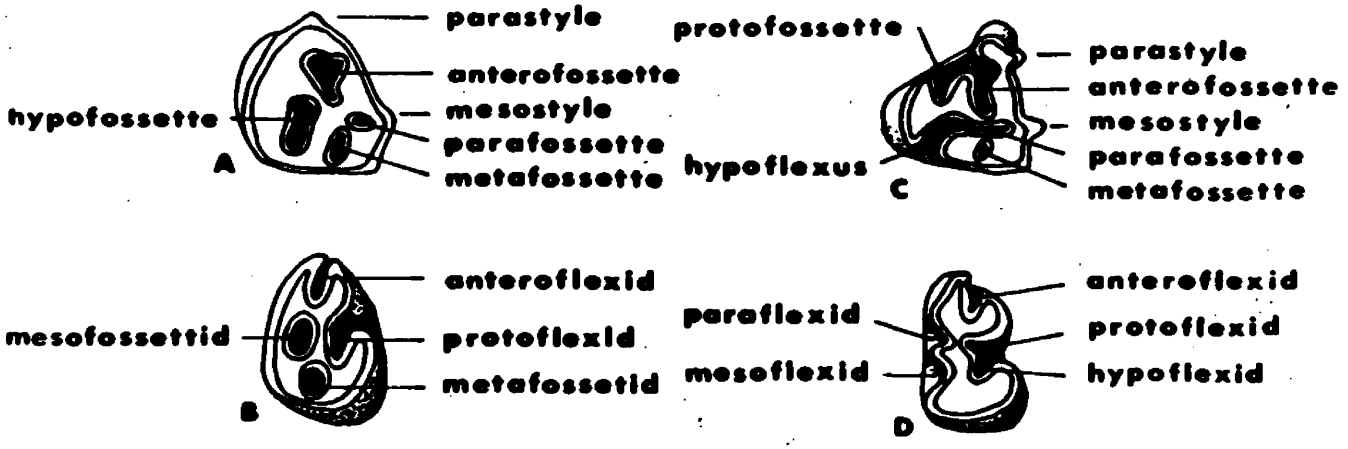
Type locality.---MV 7303, Big Wash South.

Referred material.---UM 5102, P_4, from MV 7303; UM 4040, P_4, from MV 7306; UM 5284, P_4, from MV 7303.

Etymology.---Named for the Yearian family, pioneer settlers in the valley and owners of the Peterson Creek Ranch for many years. (Pronounced year' yan.)

Distribution.---Known from the type locality only.

Diagnosis.---P^3 with base of tooth oval, crown flattened on labial and posterolingual sides; small style lingual to posterior corner of tooth, beginning half way from base of crown and extending ventrad to occlusal surface. P^4 over twice the anteroposterior length of M^1 in contrast to *M. hippodus* whose P^4 is only about 1¼ times longer than M^1; anterior cingulum complete or interrupted by very narrow extension of anterofossette; labial surface of paracone between parastyle and mesostyle convex outward; external surface of metacone posterior to mesostyle convex outward; hypoflexus constricts to form parafossette which is first lake to disappear with wear. M^1 compressed, smaller than M^2. M^2 with four fossettes. Mesostyles on M^{1-2}.

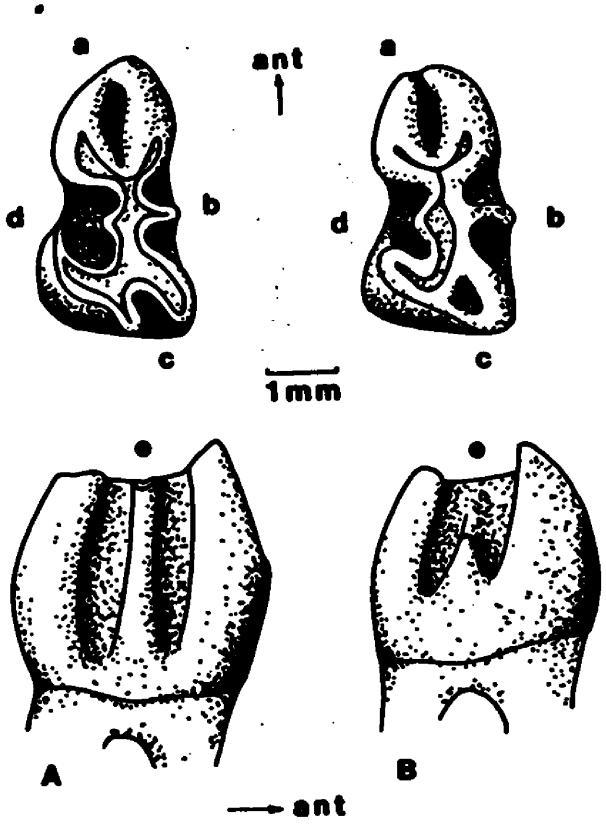


Text-fig. 4. Nomenclature of dentition of Promylagaulus and Meniscomys: A. P^4 of Promylagaulus lemhiensis; B. P_4 of P. Lemhiensis; C. P^4 of Meniscomys yeariani; D. P_4 of M. yeariani.

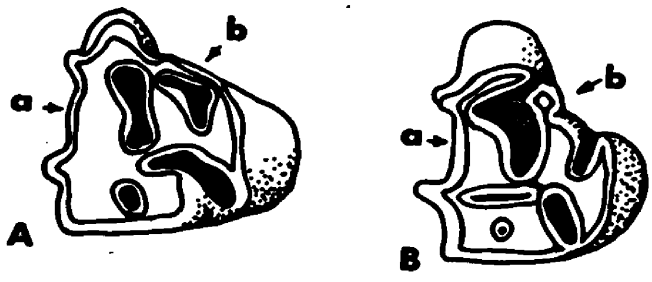
P_4 with anteroflexid extending down to within 0.5 mm of the base of the enamel while in the much higher crowned M. petersoni the type specimen measured 2.0 (Text-fig. 5a); the anteroflexid closes in M. hippodus to form the anterofossettid but would not close in M. yeariani even with extreme wear; the metastylid is short, measuring 1.7 in contrast to M. petersoni in which it is over 2.8 (fig. 5b) and its base lengthens posteriorly, in M. hippodus the metastylid extends posteriorly to a greater degree; an entofossettid in an unworn tooth would be removed by moderate wear in contrast to M. hippodus in which the fossettid is preserved after considerable wear and contrasting with M. petersoni in which an entoflexid persists with considerable wear (fig. 5c); protoflexid and hypoflexid combine on the labial side; metaflexid larger than paraflexid and separated from it by sharp ridge expanding lingually into metaconid; hypoflexid does not close with wear in contrast to M. hippodus in which a hypofossettid is present.

M. yeariani larger than M. milleri which has P_4 and M_3 reduced in anteroposterior diameter.

Discussion.---M. yeariani occurs stratigraphically below M. petersoni and is less hypsodont. It would seem to be more primitive than M. petersoni or M. hippodus in having a simpler occlusal pattern in which the anteroflexid remains, the entofossettid is shallow and the hypoflexid does not form a hypofossettid with wear.



Text-fig. 5. Comparison of P_4s of A. Meniscomys petersoni and B. M. yeariani.



Text-fig. 6. Comparison of P^4s of A. Meniscomys yeariani and B. Niglarodon sp..

MENISCOMYS PETERSONI sp. nov.

PLATE 2, fig. 7, Text-fig. 4, 5, Table 1

Type.---UM 5194, ramus with P_4 - M_3.

Type locality.---MV 7303, Big Wash North.

Referred material.---UM 5414, rostrum with incisors.

Etymology.---Named for Peterson Creek (type locality).

Distribution.---Known from type locality only.

Diagnosis.---Hypsodont, thickened enamel on labial side of teeth. P_4 with anteroflexid extending down to 2.0 mm above base of enamel in contrast to M. yeariani in which it extends down to 0.5 mm (Text-fig. 5a); metastylid over 2.8 mm in height from base of enamel, much greater than M. yeariani (fig. 5b); metastylid extends prominently lingually at right angles to anteroposterior axis of tooth, base expands but not directed posteriorly as in M. hippodus; deep entoflexid in contrast to M. yeariani (fig. 5c); hypoflexid may constrict upon wear to form hypofossettid in contrast to M. yeariani (fig. 5d); anteroposterior length about 60% greater than M. milleri. M_{1-3} with two lingual flexids and labial flexid, anterior lingual flexid closing to form fossettid with wear. M_3 with third flexid extending from posterolingual corner to middle of tooth, constricting to form second fossettid upon wear in center of tooth in contrast to M. hippodus where third flexid also closes posterad to form a third fossettid. Molars increase in length

from M_1 to M_3. (Text-fig. 4 C & D for nomenclature of dentition.)

Discussion.---M. petersoni is more advanced than M. yeariani in being more hypsodont and having a more complex occlusal pattern. An entoflexid persists with considerable wear, a hypofossettid forms with wear from the hypoflexid, an anterofossettid may form with considerable wear from the anteroflexid. This stage of development is much nearer that of the type of M. hippodus than that represented by M. yeariani.

NIGLARODON Black, 1961

Type species.---Niglarodon koerneri, YPM 14024, right jaw with P_4 - M_3 lacking incisor, coronoid process and angle, from Fort Logan Formation, Meagher County, Montana.

Distribution.---Early Miocene, Arikareean of Montana and Idaho.

NIGLARODON sp. indet.

PLATE 2, Figs. 1 - 3, Text-fig. 6

Referred material.---UM 5101, incomplete, badly crushed skull with dentition, missing nasals, parietals, zygoma and occiput, from MV 7303.

Description.---Upper incisor cross section is ovoid, anterior surface forms a right angle with flattened medial surface and there is a faint groove near the median border of the anterior surface. The enamel extends on to the labial and medial surfaces. The base of P^3 is oval and the crown is flattened labially and posterolingually and may or may not have a posterior style as Meniscomys yeariani. P^4 is without the anterior cingulum connecting the protocone to the parastyle (Text-fig. 6b). An anterofossette is enclosed but with a narrow extension to the anterolingual surface. The protoflexus is present and a constriction of the ridge connecting the protoconule to the parastyle delineates a stylar cusp. The external surface of the paracone between the parastyle and mesostyle is flat (fig. 6a). A mesostyle is present. The external surface of the metacone is concave labially. The metafossette is first lake to disappear with wear. The hypoflexus

closes medially to form a long shallow parafossette. The base of the hypoflexus extends down to within 1.10 mm of the base of the enamel. The anterior lobe of P^4 is relatively much greater than in Meniscomys. M^1 has mesostyle and metastyle. M^2 has four fossettes, mesostyle and small metastyle. M^3 has a weak mesostyle, three fossettes and two posterior flexes. The crowns of the upper cheek teeth are higher and more pronounced than in M. yeariani. (Text-fig. 4 C & D for nomenclature of dentition.)

Discussion.---The type and only previously described specimen of Niglarodon is a lower jaw from the Fort Logan Formation of Montana (Black, 1961, p. 3). UM 5101, a partial skull with upper dentition, is referred to Niglarodon by Don W. Rassmussen (personal communication, 1975) based on comparison with a skull with jaws attached that he collected in the Deer Lodge Valley of western Montana (specimen housed at the University of Kansas). His material is being prepared for publication at this time.

The missing anterior cingulum of P^4 and greater length of the anterior lobe of P^4 are the most conspicuous differences between Niglarodon and Meniscomys. Niglarodon has upper cheek teeth with higher crowns; metastyles are also present. The absence of the protofossette in the P^4 of Niglarodon resembles that condition in Promylagaulus lemhiensis.

Family MYLAGAULIDAE Cope, 1881

PROMYLAGAULUS McGrew, 1941

Type species.---Promylagaulus riggsi, FM P26256, facial region of skull with incisors and cheek teeth, from four miles south of Porcupine, South Dakota, top of lower Rosebud beds.

Included species.---Type plus P. lemhiensis sp. nov.

Distribution.---Early Miocene, Arikareean of South Dakota, Nebraska, Colorado, Wyoming and Idaho.

Generic description (revised).---Dental formula $\frac{1}{1}\frac{0}{0}\frac{2}{1}\frac{3}{3}$, incisors broad, slightly convex anteriorly. P^3 small, conical. P^4 quadrangular to roughly oval; mesostyle and parastyle present; hypsodont; four or five lakes present initially. Upper molars with faint mesostyle, number of lakes variable according to degree of wear, from four or five to none.

PROMYLAGAULUS LEMHIENSIS sp. nov.

PLATE 1, Figs. 5-10, Text-figs. 7-10, Table 2

Type.---UM 4038, left maxilla with P^3 - M^2, right P^3, right premaxilla with root of I/.

Type locality.---MV 7303.

Hypodigm.---Type plus UM 5193, broken cranium with M^{1-3}, jaw fragments with M_{2-3}; ISU 18594, right jaw with P_4 - M_3; ISU 18601, broken P^4,

M^{1-3}, P_4; UM 4039, P^4; UM 4055, P^4; UM 5285, rostrum with I/ P^3 - M^3; all from MV 7303 (ISU locality 59003).

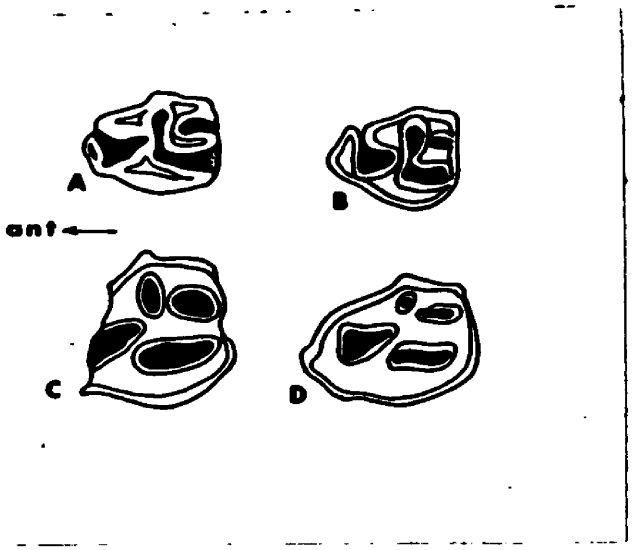
Etymology.---Lemhi from the Lemhi River, a name given by early Mormon settlers in 1847.

Distribution.---Known from type locality only.

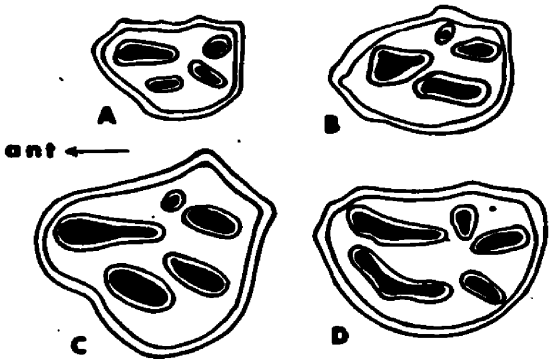
Diagnosis.---25% larger than Promylagaulus riggsi in dental measurements. P^4 roughly oval in occlusal outline; mesostyle posterior to transverse axis; parastyle at anterior margin; anterofossette wide anterad; parafossette lingual to mesostyle; metafossette present; hypofossette parallel to metafossette and posterad to transverse axis; unworn P^4 with parafossette joined with hypofossette; four fossettes rather than five as in P. riggsi.

P_4 hypsodont, in unworn condition with anteroflexid, protoflexid and mesoflexid; mesoflexid closing with wear to form mesofossettid; irregular metafossettid in unworn tooth becomes nearly round in worn tooth. M_{1-2} with labial and lingual flexids, one fossettid posteriorly and two anteriorly placed plus a median fossettid formed by closure of lingual flexid. M_3 with similar pattern of fossettids but with labial flexid only. (Text-fig. 4 for nomenclature of dentition.)

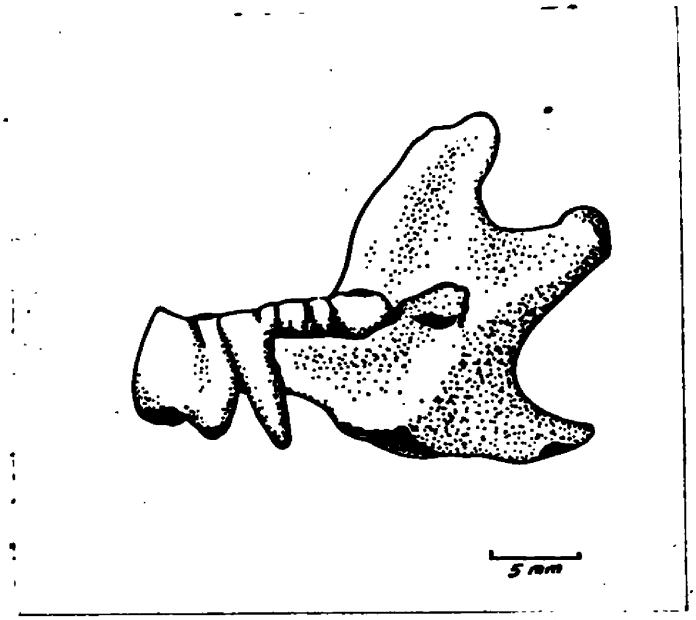
Description.---UM 4038 has well-worn dentition. The anterior face of the upper incisor is convex and the angles with the labial and medial faces are about equal. The upper molars have thickened enamel on the lingual faces, the enamel thinning with wear on borders with adjoining



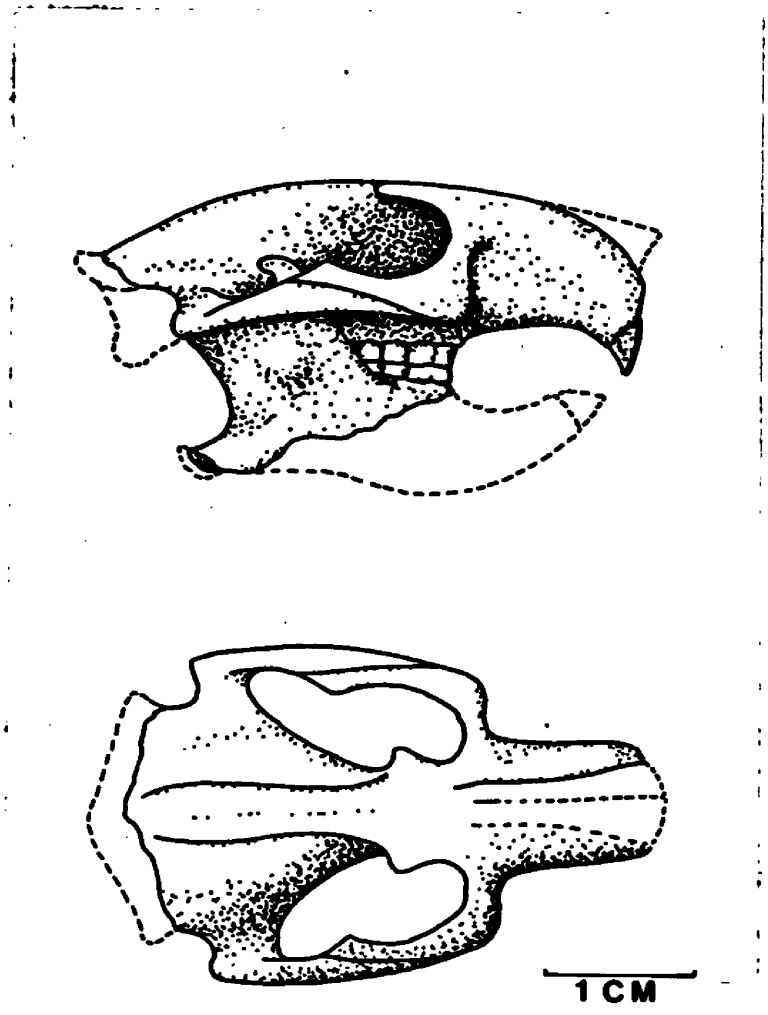
Text-fig. 7. Stages of wear in P^4s of Promylagaulus lemhiensis: A. UM 4039; B. UM 4055; C. ISU 18601; D. UM 4038.



Text-fig. 8. Occlusal patterns of P^4s of mylagaulids: A. Promylagaulus riggsi McGrew 1941; B. Promylagaulus lemhiensis; C. Mylagaulodon angulatus Sinclair 1903; D. Mesogaulus novellus (Matthew) Black and Wood, 1956.



Text-fig. 9. Medial view of partial right jaw with P_4 - M_3 of Promylagaulus lemhiensis, ISU 18594.



Text-fig. 10. Restoration of skull and jaw of Promylagaulus lemhiensis.

teeth. M^1 is compressed anteroposteriorly with one or more fossettes disappearing with wear. M^2 is longer anteroposteriorly with two small fossettes labially and one lingually, the two small fossettes disappearing with wear. M^3 has two fossettes transversely placed, the labial fossette disappearing first with wear.

UM 5193 is a crushed and broken cranium with the ascending rami of both jaws attached. It has M^{1-3} and M_{2-3}. The frontals have prominent postorbital processes and supraorbital crests which continue posteriorly as temporal ridges to join in a low sagittal crest just anterior to the occiput. The jugal is robust and has a small postorbital pillar. A prominent ridge extends across the lateral face of the jugal from just posterior to the postorbital pillar downward to a point below the anterior rim of the orbit marking the attachment of the masseteur muscles (Pl. 1, Fig. 5).

UM 5285 is a rostrum with I/ P^3 - M^3. The rostrum is short and heavy. The upper incisors are worn down to the premaxillaries posterad. The jugal is massive anteriorly (Pl. 1, Fig. 6).

A restoration of the skull and jaw (Text-fig. 10) was made using UM 5193, partial skull; UM 5285, rostrum; UM 4038, palate; ISU 18594, jaw; and figures of a jaw referred to P. riggsi by McKenna and Love (1972, p. 24).

M_2 and M_3 of UM 5193 are well-worn and sub-round in occlusal outline with a single large round fossettid centrally placed on each tooth. The corresponding molars of a young individual as in ISU 18594 are longer anteroposteriorly with four fossettids, the median fossettid

being much deeper. The M_2 with little wear has lingual and labial flexids and the M_3 has a labial flexid only. This considerable change in the character of the teeth with wear was noted by McKenna and Love (ibid., p. 24) and by Macdonald (1972, p. 25).

ISU 18601 has associated upper and lower cheek teeth. ISU 18594 is a ramus with teeth showing only a slight degree of wear. P_4 of ISU 18594 is very hypsodont and resembles, in this respect, the P_4 of the later mylagaulids (Text-fig. 9). The dentition of ISU 18594 resembles that of AMNH 10824, P. cf. riggsi, figured by McGrew (1941, p. 9) but in the figured specimen the lingual flexid in M_2 has not yet closed to form a fossettid and there is only one fossettid anterad in M_2 rather than the two in M_1 and M_2. P. lemhiensis has four fossettids in all three lower molars in the early stage of wear (Pl. 1, Fig. 8).

In AMNH 56333, a lower jaw referred to P. riggsi (McKenna and Love, 1972, p. 23), the pattern of P_4 is similar to that in ISU 18601 (Pl. 1, Fig. 9), but it has only one fossettid median to the labial flexid. The specimen described by McKenna (ibid.) shows considerable wear which may account for the absence of the metafossettid.

Discussion.---There are only four fossettes present in P^4 of P. lemhiensis, while in P. riggsi there are five present in early stages of wear (Macdonald, 1972, p. 25). The protofossette is lacking in unworn teeth in P. lemhiensis (Text-fig. 7). In the unworn P^4 the hypofossette joins the parafossette to form an L-shaped pattern very reminiscent of Meniscomys. The anterofossette of P^4 widens anteriorly to suggest Mylagaulodon (Sinclair, 1903, p. 143), but the outline of the

occlusal surface is triangular and larger in Mylagaulodon. The upper molars are similar in shape to those of P. riggsi, but in the type of P. lemhiensis, which shows considerable wear, there is no fossette in M^1 and there are three fossettes in M^2, while the type of P. riggsi has one fossette centrally placed in each molar. Macdonald (ibid., p. 25) notes four fossettes in little-worn M^3s from the Wounded Knee area of South Dakota.

P. lemhiensis differs from P. riggsi in being larger and in having a P^4 with a more oval occlusal surface and having one less fossette. The lower dentition, however, is very similar to that referred to P. riggsi. Through this similarity it seems more reasonable to consider P. lemhiensis a new species rather than a new genus.

P. lemhiensis represents an advance over P. riggsi in being larger and in having an oval shaped P^4 that resembles the later mylagaulids. In this respect, it is similar to Mesogaulus (Black and Wood, 1956, pp. 674 & 683) as well as to Mylagaulodon (Text-fig. 8) which has been considered intermediate between Promylagaulus and Mylagaulus (McGrew, 1941, p. 20). The absence of the protofossette in the P^4 would seem to preclude P. lemhiensis from the direct ancestry of the mylagaulids, as this fossette is present in all the forms used by McGrew in tracing the evolution of the mylagaulids from Haplomys to Mylagaulus.

Family GEOMYIDAE Gill 1872

Subfamily ENTOPTYCHINAE Miller and Gidley 1918

ENTOPTYCHUS Cope 1878

Type species.---Entoptychus cavifrons, AMNH 7052, skull with P^4 - M^3. Terminal rostrum, zygomatic arches, posterodorsal cranium, occipital, pterygoids, parts of maxillary and bones of orbits missing. From somewhere along the John Day River, Oregon.

Included species.---Type plus E. basilaris Rensberger, E. germannorum Wood, E. wheelerensis Rensberger, E. montanensis (Hibbard and Keenmon) Rensberger, E. minor Cope, E. transitorius Rensberger, E. productidens Rensberger, E. planifrons Cope, E. individens Rensberger, E. fieldsi n. sp., and E. sheppardi n. sp..

Distribution.---Early Miocene, middle Arikareean of Oregon, Montana, and Idaho.

Generic description.---Groove near medial border of anterior upper incisor face prominent; no indication of central groove. Rostrum very elongate in fully mature specimens; upper incisors with proportionately lengthened radius of curvature, but not procumbent. DP_4 with metaconid connected to anteroconid; anteroposterior crest from protoconid undeveloped; valley between lophs open centrally; hypoconid connected with hypostylid and entoconid; postfossette developed, closed by low, short posterior cingulum. Anterior cingulum present on P_4, but reduced. Posteromedial process usually present on metaconid of M_{1-2}. Strong

trend toward hypsodonty in various structures of cheek teeth and related structures of skull and mandible, including extension of dentine tracts, elongation of crowns, loss of roots (Rensberger, 1971, p. 71).

ENTOPTYCHUS FIELDSI sp. nov.

PLATE 6, Figs. 1 to 4, Table 3

Type.---UM 5192, left ramus with P_4 - M_2, right ramus with /I - M_3.

Type locality.---MV 7303, Big Wash North.

Referred material.---UM 5191, skull lacking occiput; UM 5415, tibiofibula.

Etymology.---Named after Robert W. Fields, professor of vertebrate paleontology at the University of Montana.

Distribution.---Known from type locality only.

Diagnosis.---Anterior face of lower incisor flat, angle between anterior face and labial face rounded, between anterior face and medial face sharp. P_4 with three cusps, central protoconid compressed; anterostylid present; posterior face of metalophid slopes anteriorly in early stage of wear (Pl. 6, Fig. 4) in contrast to E. sheppardi (Pl. 4, Fig. 4); hypolophid nearer the same width as metalophid in contrast to E. sheppardi in which the hypolophid is much wider than metalophid. Differs from the John Day forms in the character of the P_4, in the labial edges of the occlusal surfaces of the lower molars being rounded rather than nearly straight as in the John Day forms.

(Text-fig. 11, nomenclature of dentition.)

Discussion.---Entoptychus fieldsi is a very primitive entoptychine with little evidence of enamel dentine chevrons on the lower molars. Although the P_4 is different in proportion from that of E. sheppardi the cusp pattern is similar and the anterior cingulum is very nearly alike in both species. It occurs at a lower stratigraphic level (Text-fig. 2) and is probably ancestral to E. sheppardi. The skull UM 5191 was found in close proximity and a few feet below the type and as the two specimens are the only ones yet discovered and agree in size, the skull is tentatively referred to this species. The skull has a short rostrum but the rostrum-skull depth ratio falls within the range of Entoptychus of the John Day (Rensberger, 1971, p. 150). The height of the frontal crests is quite low in relation to the rostrum length and in this respect is more nearly like Gregorymys (ibid, p. 149). The dentition of UM 5191 is well worn, and it is difficult to make any comparison with Entoptychus montanensis in which the P^4s are unworn. The diastema in E. montanensis is 15.0 mm while in E. fieldsi is only 10.64 mm. The interorbital width is relatively greater than in E. sheppardi. The lower incisor has a smaller radius of curvature than E. sheppardi, the upper and lower tooth rows are shorter, the skull depth and length are smaller, and the tibiofibula is smaller; all indicating E. fieldsi to be a smaller animal.

ENTOPTYCHUS SHEPPARDI sp. nov.

PLATES 3, 4 & 5, Text-figs. 11 & 12, Tables 4 & 5

Type.---UM 5395, skull lacking occiput and basal cranial region.

Type locality.---MV 7303, Rodent Wash South.

Hypodigm.---Type plus UM 5394; UM 5396, palate with I/ DP^4 - M^3; UM 5397, skull fragment with DP^4 - M^3; UM 5398, jaw with /I DP_4 - M_3; UM 5399, jaw with /I DP_4 - M_2 erupt. M_3; UM 5400, jaw with /I erupt. P_4 M_{1-3}; UM 5401, jaw with /I P_4 - M_3; UM 5402, jaw with /I erupt. P_4 M_{1-2}; UM 5403, jaw frag. with M_{1-3}; UM 5404, jaw frag. with DP_4 erupt. P_4 M_{1-2}; UM 5405 M_1 or M_2; UM 5406, M_1 or M_2; UM 5407, M_1 or M_2; UM 5408, tibiofibula; UM 5410, distal tibiofibula; UM 5411 distal portion humerus; UM 5412 frag. distal portion humerus (all of the above specimens found within one block 6 x 4 x 2 inches); UM 5418, sacrum; UM 5112, left jaw, three thoracic vertebra and seven lumbar vertebra articulated, incomplete sacrum and right pelvis, frags. of right and left scapulas, right and left femurs, left tibiofibula, left calcaneum, navicular and metatarsal, six phalanges, six ribs, and a frag. of right parietal and squamosal; UM 5111, posterior half of left and right jaws with broken P_4 - M_3.

Etymology.---Named for Gayle Sheppard, my field assistant, who discovered the skeleton UM 5112, the first geomyid material to be found at Peterson Creek.

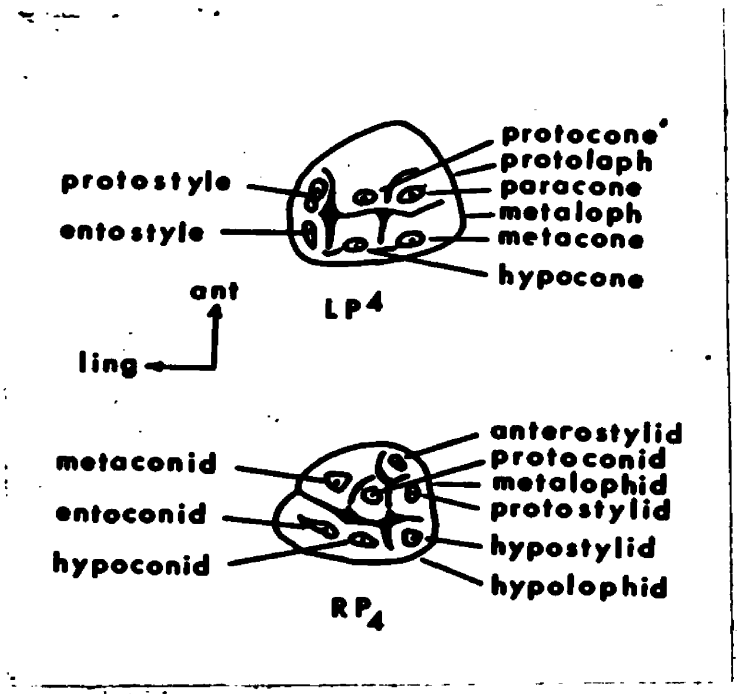
Distribution.---Known from type locality only.

Diagnosis.---Large geomyid, long rostrum, primitive dental characters. Height of lingual chevron on M_1 very short or nonexistant (Rensberger, 1971, p. 11, definition of measurements). Length of anterior enamel on M^1 0.7 mm, greater than E. basilaris. Length of anterior of two labial root branches on M_2 0.7 mm, less than in E. basilaris. Differs from John Day entoptychines in having rounded labial sides of the lower molars, in having a P^4 in unworn condition with the protostyle connected to the entostyle and separated from the protocone by a deep valley, in there being no posterior cingulum on M^3, and in having more robust limb elements. Differs from E. montanensis in having the protostyle separated from the protocone by a deep valley and by the absence of strong posterior cingulum on M^3. Differs from E. fieldsi in the P_4 which has a proportionately wider hypolophid in E. sheppardi, and in the metalophid which in E. sheppardi is inclined forward in an unworn stage of wear. (Text-fig. 11, nomenclature of dentition.)

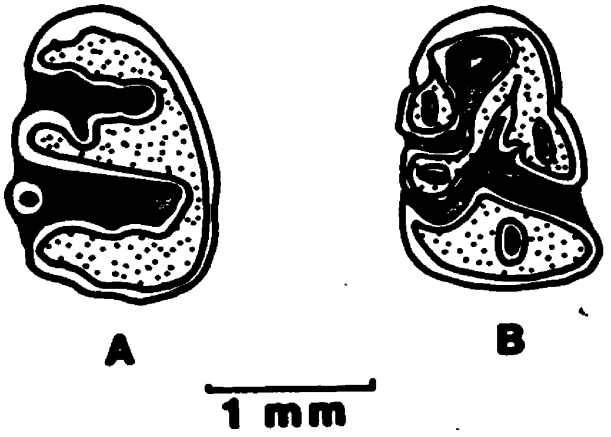
Description.---The skull is comparatively shallow in palatonarial depth with a long rostrum. The nasals extend back just past the anterior rims of the orbits. The supraorbital ridges merge posteriorly. The lachrimals extend prominently posteriorly into the orbits.

The massetric crest on the jaw is prominent and ends just in front of the anterior border of P_4.

UM 5397 is the upper dentition of a juvenile with moderately worn DP^4s, and erupting M^3s (Pl. 4, fig. 1). The DP^4 has three lingually



Text-fig. 11. Nomenclature of dentition of premolars of Entoptychus sheppardi.



Text-fig. 12. Deciduous premolars of Entoptychus sheppardi: A. DP^4 UM 5397; B. DP_4 UM 5398.

connected lophs (anteroloph, protoloph and metaloph) (Text-fig. 12). The protoloph and the metaloph each have three transversely placed cusps. There is an additional cusp attached to the anterior face of the metacone in both right and left DP^4s but this cusp is not present in UM 5396 in either DP^4. M_1 and M_2 have protoloph and metaloph with three cusps. There is an anterior cingulum extending from protostyle to paracone which may enclose a small fossette upon wear. The protostyle and hypostyle-entostyle are separated by a valley. The central valley between the protoloph and metaloph is narrow, widening labially. M^3 has the valley between the protostyle and hypostyle-entostyle not as deep as in M^1 or M^2 and in this specimen, it is blocked by a small cusp. An anterior cingulum is present. The posterior cingulum is present as a faint carrinate row of tiny cusps joining the posterior surfaces of the metacone, hypocone and hypostyle. This cingulum is not nearly as prominent as in the John Day forms or as in E. montanensis.

UM 5395, the type, has newly erupted P^4s. In the P^4 the protostyle is connected to the entostyle and the protostyle is separated from the protocone by a deep valley, a primitive condition.

UM 5399 is the lower dentition of a juvenile with DP_4 and erupting M_3s. The DP_4 has a row of cusps forming an anterior cingulum. A narrow crest joins the posterior lingual cingular cusp (anteroconid) to the protoconid-protostylid. The metaconid is joined anteriorly to the anteroconid. The hypolophid is worn and contains a small fossettid centrally located. M_1 and M_2 have prominent anterior cinguli. The metalophid and hypolophid are three-cusped. A cingular cusp is anter-

ior to and joined to the protostylid, and the protostylid and this cingular cusp are separated from the protoconid by a deep valley. The M_3 has a minute hypostylid on the labial edge of the hypolophid. The cingular cusp attached to the protostylid is more of a sharpened ridge than a cusp as in M_1 and M_2.

UM 5400 has erupting P_4s. The P_4 has an anterior cingulum usually with three cusps originating with the protostylid and terminating anteriorly with the anterostylid. Lingual to the protostylid is the protoconid and this is separated from the metaconid by a valley not as prominent as that separating the protoconid from the protostylid. The hypolophid has three cusps with the hypostylid separated from the hypoconid by a deeper valley than that separating the hypoconid from the entoconid.

In the process of wear the transverse valleys of the molars enclose lakes only briefly before the tooth becomes a simple enamel bounded peg.

A more complete description of the skeletal elements has been done by Rensberger (1971) so that only salient points and differences will be noted here. All comparisons are with the John Day forms from Rensberger's 1971 publication.

Fragments of the distal ends of the right and left scapulas have axillary borders that are slightly convex anterad. The coracoid borders are straight for a short distance, then bend dorsally and extend straight to the point where the dorsal halves of the scapulas are missing.

The pelvis has a depression in the dorsal border of the ilium behind the area of articulation with the transverse processes of the sacral vertebra, in contrast to Pleurolicus sulcifrons which has a straight dorsal border (Rensberger, 1973b, p. 56).

The femur is similar to that of P. sulcifrons in being robust and having a shaft straight in median view unlike the curved shaft in the John Day entoptychines.

The tibiofibula is more robust than in either P. sulcifrons or in the John Day entoptychines. In the specimen figured in Plate 5, figs. 5, 6 & 7, the epiphysis has partially separated from the shaft posterad and has rotated counterclockwise about 25 degrees.

The calcaneum (Pl. 5, fig. 12) differs from the John Day forms in being broader and more expanded posteriorly, in not having a dorsal keel, in having a broader groove for the tendo-calcaneum, in being broader through the peroneal process and sustentaculum, and in having a cuboid facet that does not extend so far anterad.

With a width-length ratio of .60 as compared with .47 to .50 (Rensberger, ibid., p. 99) the astragalus is shorter and broader than in the John Day entoptychines. The lateral surface of the neck has a pronounced convexity. The interarticular groove is deeper and better-defined, and the lateral calcaneal facet is transversely broader.

The navicular (Pl. 5, fig. 8) is similar to that in the John Day forms but is relatively shorter in anteroposterior length.

The distal phalanx (Pl. 5, fig. 9) has the ventral tuberosity extending deeper.

Discussion.---The primitive features of Entoptychus sheppardi, i.e., the nearly straight enamel dentine border of the molars, the short length of the enamel plates on the anterior face of the upper molars, the long roots and lower degree of hypsodonty, and the robustness of the skeleton all mark this form as a very early entoptychine. This form along with E. fieldsi, its probable ancestor, may be a separate lineage restricted to the intermontane basins, and paralleling the development of the John Day entoptychines. If this is true, the line may have had its origin somewhere near the point of origin of Sanctimus (see Rensberger, 1973a, p. 848). Another alternative is that this lineage is ancestral to the John Day entoptychines, which could be possible in that the more advanced of the two Idaho species, E. sheppardi, is about equivalent to or more primitive than, the most primitive of the John Day species, E. basilaris. The latter alternative seems more probable in that E. sheppardi occurs with Meniscomys petersoni which is like the forms of Meniscomys from the upper part of the Meniscomys Concurrent-range Zone of the John Day. This would place E. sheppardi prior in time to E. basilaris. A primitive entoptychine from nearby in Montana to be described in a forthcoming paper by this author, appears to be higher stratigraphically, and is more typical of the John Day entoptychines, with similar dental characters, especially in the straight labial sides of the lower molars.

The specimens with the deciduous dentition would verify Rensberger's (1968) and Black's (1969) notations that Palustrimus lewisi Wood 1935 is the upper deciduous premolar of Entoptychus.

All of the specimens of E. sheppardi with the exception of UM 5418, sacrum, UM 5112, partial skeleton, and UM 5111, rami fragments, were found together in one small block about 6 x 4 x 2 inches square along with many small skeletal elements that were not recoverable. Because of the excellent state of preservation of the skulls and jaws, this group is probably the fecal residue of a predatory bird such as an owl.

Macdonald (1970, p. 36) described SDSM 6257, a skull and lower jaw, which is similar to E. sheppardi in the worn P_4 having a three-cusped protolophid (metalophid) and a reduced anterior cingulum forming a single cusp in the center of the anterior face of the tooth. He referred this specimen to Gregorymys formosus. Unworn P_4s from the same area referred to G. formosus differ from E. sheppardi in that the lateral cusps of the protolophid (metalophid) are oriented approximately 45 degrees to the midline while they are parallel to the midline in E. sheppardi. In this form of G. formosus there is an anterior cingulum extending from the protoconid, with three cusps, as in E. sheppardi.

The skull of UM 5394 is of an older individual than UM 5395 and is used in the plates because of its being more complete.

Family CRICETIDAE Rochebrune, 1883

PACICULUS Cope, 1878

Type species.---Paciculus insolitus, AMNH 7022, maxilla with M^{1-3}, from the John Day Formation of Oregon.

Distribution.---Early Miocene, Arikareean of Oregon, South Dakota, Montana and Idaho.

Generic description.---M^{1-3} with five transverse crests reaching labial border, one reentrant fold on lingual border turning anteriorly.

PACICULUS INSOLITUS Cope, 1878

PLATE 6, Figs. 5-8, Text-fig. 13, Table 6

Referred material.---UM 5107, right maxilla with M^{1-3}; UM 5108, left maxilla with M^{1-3}; UM 5109, right maxilla with M^{1-3}; UM 5104, right and left jaws with /I - M_2; UM 5105, left jaw with M_{1-3}, right jaw with /I - M_3; UM 5106, right and left jaws with /I - M_3, UM 5282, P_4, all from MV 7303.

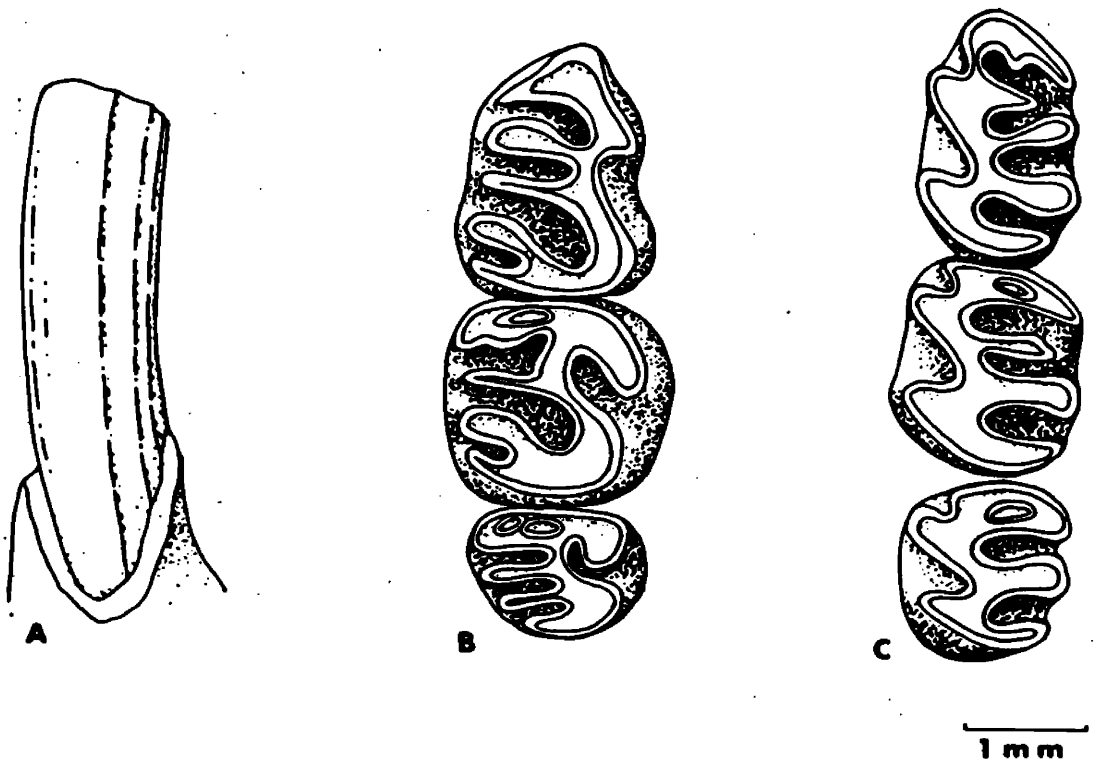
Description.---M^{1-3} have four labial reentrant folds and one lingual reentrant fold, and five subequal transverse crests all reaching the labial surface. M^1 has a prominent anterocone and the anterior labial reentrant fold turns posteriorly around the paracone. M^2 is a quadrate in shape. M^3 is sub-round, wider than long; the anterior fold closes with wear to form a fossette; the second reentrant may connect with the lingual reentrant fold to divide the occlusal surface of the

tooth; the third reentrant separates the mesoloph from the metacone and the fourth reentrant defines the posterior cingulum.

/I has three fine ridges extending down the anterior face, one near the center of the face and two close together nearer the labial face, and there is a faint furrow near the medial border. M_1 has an expanded anteroconid; there are four lingual reentrant folds, the first turning anteriorly and joining with the second fold in a common opening to the lingual surface; the third reentrant turns slightly posteriorly; the fourth reentrant is large and there is a small labial reentrant at the anterolabial corner of the tooth, and a large labial reentrant at the middle of the tooth turns posteriorly. M_2 has a similar pattern of folds but the metalophid and anteroconid may coalesce upon wear to enclose a small fossettid. M_3 has two labial and three lingual reentrant folds; the metaconid and the anteroconid are separated by the anterior lingual reentrant which may close with wear to form a fossettid and the entoconid and hypoconulid merge lingually with wear to enclose a fossettid. (Terminology from Wood, 1936, p. 388).

Discussion.---All six UM specimens were found in place within a space of about 3 cm square along with some fragments of small limb bones, probably representing fecal residue.

The upper molars of the UM specimens are about 5% smaller than in the type of P. insolitus, but no specific differences can be discerned between them and the type. This is the first recorded occurrence of associated upper and lower dentition; however, a lower dentition was figured by Cope (1884, Pl. 66, fig. 32) and identified as P. insolitus.



Text-fig. 13. Paciculus insolitus Cope 1878: A. anterior view of lower left incisor showing longitudinal ridges, UM 5106; B. upper right M^{1-3}, UM 5108; C. lower left M_{1-3}, UM 5106.

That figure is very small and the teeth appear to be well worn. The reentrant folds are similar to those in the UM specimens but the anterior and posterior lingual reentrants of M_1 are closed to form fossettids. M_2 of the figure has a fossettid in the position of the mesoconid and the posterior reentrant is closed to form a fossettid. M_3 shows only two lingual reentrants. This figure of the lower jaw was not mentioned by Wood (1936, p. 4) in his redefinition of Cope's type of P. insolitus.

Clark (Clark, et al., p. 44) suggested that the type specimen of Cotimus alicae Black (1961b, p. 73) might represent the lower dentition of Paciculus montanus Black (1961a, p. 10); however, the dentition of C. alicae differs from that of P. insolitus in the character of the anteroconid of M_1 and in having a small crest between the entoconid and the mesolophid. As the upper dentition of P. montanus is very close to P. insolitus, it could be assumed that the lower dentition of P. montanus would also resemble P. insolitus. Cotimus alicae is therefore probably a valid taxon.

P. montanus Black (ibid.) from the Deep River Formation of late Hemingfordian age is characterized as having higher crowned and narrower upper molars than those in the type of P. insolitus. The UM specimens are relatively low crowned and would conform chronologically more nearly to the type of P. insolitus from the John Day Formation.

In a specimen described by Macdonald (1970, p. 52) as P. macgregori the mesoloph-metaloph reentrant of M_3 almost joins the lingual reentrant, as in UM 5109. This character is present in only one of

three UM specimens and is not considered diagnostic.

Order CARNIVORA Bowdich, 1821

Suborder FISSIPEDA Blumenbach, 1791

Superfamily CANOIDEA Simpson, 1931

Family PROCYONIDAE Bonaparte, 1850

PROCYONID gen. et sp. indet.

Material.---UM 5233, humerus lacking proximal epiphysis, articulated with ulna and radius lacking distal ends, from MV 7303.

Description.---This portion of a right forelimb resembles a modern raccoon but is about 25% smaller.

Order ARTIODACTYLA Owen, 1848

Family MERYCOIDODONTIDAE Thorpe, 1937

Subfamily DESMATOCHOERINAE Schultz and Falkenbach, 1940

MEGOREODON Schultz and Falkenbach, 1940

Type species.---Megoreodon grandis (Douglass), CM 990, from Canyon Ferry beds, Lewis and Clark County, Montana.
Promerycochoerus grandis Douglass, 1907.

Distribution.---Early Miocene, Arikareean of Montana, Wyoming, Nebraska and Idaho.

Generic description (revised).---Skull large, narrow to wide, upper line of skull nearly straight; sagittal crest high, not heavy; paroccipitals long, largest diameter of base in a posterointernal direction closely pressed against the posteroexternal portion of the tympanic bulla and near the high postglenoid processes, elongated foramina in large, deep depressions on each side of midline of exoccipital; frontals moderately wide with oblong protuberance usually present along midline above posterior border of orbits; squamosal extending posteriorly to point above posterior border of postglenoid process, somewhat U-shaped in outline from side view; malar very deep below orbit; infraorbital foramen above P^4; lacrimal fossa moderately deep, but small; elongate facial depression bounded by inflated ridge above and alveolar borders of premolars below; dentition brachydont, heavy, extending posteriorly almost to rear border of orbit; external styles of superior molars robust and prominent.

MEGOREODON GRANDIS (Douglass), 1907

PLATE 7, Figs. 1-4, Table 7

Referred material.---UM 4026, skull; UM 4027, skull, missing incisors, P^{2-3}, nasals and anterior part of frontals; UM 4024, rostral portion of skull with incisors and roots of canines and premolars, jaws with dentition lacking angles and ascending rami; UM 4025, rostral portion of skull with dentition, jaws with dentition lacking left ascending ramus and angle, proximal portion of ulna; UM 4028, jaw fragment with P_{1-4}; UM 4033 maxilla with C/- M^3 all from MV 7303. UT 40110-1, jaws with dentition lacking angles and rami; UT 40110-2, maxilla and premaxilla with C/- M^3 probably from MV 7303 but field data is lacking.

Description.---Palatonarial border is well back of M^3. There is a large fossa on anterior portion of ascending ramus separated from masseteric fossa by a plate of bone.

Discussion.---In 1907, Douglass (p. 104) described two oreodonts from the Canyon Ferry beds of Montana, Promerycocheorus grandis and Promerycochoerus hollandi. The type of P. grandis is a long narrow skull with a peculiar fossa on the anterior portion of the ascending ramus of the jaw. The palatonarial border is well back of the posterior border of the M^3s (Thorpe, 1937, p. 347). P. hollandi has a wider skull and a smaller anterior fossa on the lower jaw. The palatonarial of the type (ibid., p. 341) is nearly on a line with the posterior border of the M^3s. The type specimen of P. grandis has preorbital vacuities while the type of P. hollandi lacks them. UM 4026 has no vacuities in

but is crushed in the area anterior to the orbit, giving the appearance of a vacuity. UM 4027 may have preorbital vacuities but the condition of preservation makes verification impossible. UM 4024 lacks vacuities. A specimen in the Los Angeles County Museum (LACM 5661) labeled "Promerycochoerus grandis, Canyon Ferry beds, Montana, Earl Douglass, 1902, Acc. Carnegie" is a long narrow skull lacking preorbital vacuities but possessing the large anterior fossa of the lower jaw. Schultz and Falkenbach (1954, p. 169) questioned the opening in the skull of the holotype as being a true vacuity; moreover, they considered the presence or absence of vacuities in this genus as being of no diagnostic value.

Thorpe (1937, p. 139) placed P. grandis as a subspecies of P. montanus and listed P. hollandi as a valid species.

Schultz and Falkenbach (1954, p. 168) placed P. grandis and P. hollandi in synonymy with Megoreodon grandis, explaining the difference in width of the skulls as representing sexual variation.

Skinner (Skinner, et al., 1968, p. 426) referred seventeen specimens from the Wewela Formation of South Dakota to M. hollandi because of the wideness of the skull and heaviness of the jugal and separated the species M. grandis and M. hollandi from the synonymy of Schultz and Falkenbach.

The specimens from Peterson Creek have wider skulls than the type of M. grandis (Promerycochoerus grandis) but are not as wide as those of the type of M. hollandi (Promerycochoerus hollandi). They have the large anterior fossa of the lower jaw, and the palatonarial border is

well back of M^3. They are herein referred to Megoreodon grandis.

Subfamily PROMERYCOCHOERINAE Schultz and Falkenbach, 1949

MESOREODON Scott, 1893

Type species.---Mesoreodon chelonyx, PU 10425, partial skull and partial mandible, scapula, partial humerus, vertebrae, and thyroid apparatus, from the Smith River Valley, Meagher County, Montana.

Distribution.---Early Miocene, Arikareean of Wyoming, Nebraska, Montana and Idaho.

Generic description (revised).---Medium size; infraorbital foramen above P^3 - P^4; mandible robust; postsymphysis in area below P_3; tubercle at base of postsymphysis; ascending ramus high with slight inward curve of posterior border; anterior intermediate crest on P^1 - P^3; posterior internal crest on P_3; anterior basin or pit sometimes on P_4.

MESOREODON CHELONYX Scott, 1883

PLATE 7, Fig. 5, Table 8

Referred material.---UM 4029, palatal portion of skull with I/- M^3, broken squamosal with postglenoid process, paroccipital process, right jaw with I/- M_3, left jaw with P_1 - M_3 lacking angle and ascending ramus, from MV 7304.

Description.---The infraorbital foramen is above P^4. The postglenoid process is massive and is wide laterally. The symphysis is concave in profile. The upper canine has a deep groove on the inner face.

Discussion.---UM 4029 resembles Mesoreodon ? latidens Douglass (1907, p. 102) which was renamed Merycoides latidens by Thorpe (1937, p. 173) and which was later placed in synonymy with Mesoreodon chelonyx by Schultz and Falkenbach (1949, p. 140). Douglass noted that in the type of M. ? latidens (CM908) the cingulum on P^2 almost formed a cusp on the posterointernal portion of the tooth and enclosed a comparatively broad, shallow basin, on P^3 this internal cusp was also large. UM 4029 has a narrower and slightly smaller dentition than in the type of M. ? latidens, but has the same condition of the cingular cusps on P^2 and P^3.

UM 4029 is referred to M. chelonyx through its similarity to Douglass' type of M. ? latidens (CM908) which has been placed in synonymy with M. chelonyx.

OREODONT

Gen. et sp. indet.

Material.---UM 4034, right maxilla with DP^{2-4} M^{1-2}, from MV 7303.

Description.---This specimen represents a small immature oreodont. The posterior root of DP^1 is located labially with respect to the alveolar border of the other premolars. DP^2 is narrow, trenchant, with a strong anterior intermediate crest and posterointernal cingulum enclosing a narrow basin. DP^3 has a strong anterior intermediate crest and a very small crest between the anterior intermediate crest and the anterior external crest. The posterior cingulum encloses a basin. The tooth is quadrate, twice as long as it is wide. DP^4 has a small crest corresponding to the crest between the anterior intermediate crest and the anterior external crest on DP^3. The anterior external crescent is not developed. M^{1-2} have prominent styles. Estimated length of the permanent premolars is 38 mm and the molars 42 mm. The infraorbital foramen would be above the posterior part of P^3 when the deciduous teeth are replaced.

Discussion.---The maxilla of this small oreodont falls within the size range of Merycoides, Merychyus and Oreodontoides. As the deciduous dentition of oreodonts is poorly known and oreodont molars are not very diagnostic in themselves, this specimen cannot be given generic identification.

Douglass found the type of Merycoides cursor in the Canyon Ferry beds along with the types of Promerycochoerus grandis and Mesoreodon ?

latidens. I have referred the two larger oreodonts from Peterson Creek to the species described by Douglass in 1907, Promerycochoerus grandis, and Mesoreodon chelonyx (Mesoreodon ? latidens). If a similar relationship of large and small oreodonts exists in the Peterson Creek beds, then UM 4034 may be an immature form of Merycoides cursor.

Order PERISSODACTYLA Owen, 1848

Suborder HIPPOMORPHA Wood, 1937

Superfamily EQUOIDEA Hay, 1902

Family EQUIDAE Gray, 1821

Subfamily ANCHITHERIINAE Osborn, 1910

MIOHIPPUS Marsh, 1874

Type species.---Miohippus annectens, YPM 11275, eleven upper molar and premolar teeth, probably from the upper John Day Formation of Oregon.

Distribution.---Middle Oligocene to Early Miocene of North America.

Generic description.---Premolars $\frac{2-4}{2-4}$ typically exceed in length molars $\frac{1-3}{1-3}$. P^4 typically exceeds M^1 in width; grinding teeth with internal cingulum absent or reduced, hypostyle large, angular, more or less separate from posterior cingulum, metaloph not connected to the ectoloph.

MIOHIPPUS cf. GEMMAROSAE Osborn, 1918

PLATE 7, Figs. 6-8

Referred material.---UM 4035, M^3, P^4 or M^1, broken P^3 or P^4, mandible with dentition, lacking angles and ascending rami, all from MV 7304.

Description.---M^3 has a sharp constriction separating the protocone and protoconule. The cingulum extends from the protoconule around the protocone to the base of the hypocone where it is separated from the

hypocone by a small valley. The posterior cingulum begins on the posterior lingual corner of the hypocone and extends to the metastyle. The hypostyle is V-shaped with the apex of the V pointing anteriorly. The lingual leg of the V joins the posterior cingulum. A very subtle constriction divides the metaconule from the hypocone. The protoloph is joined by a thin ridge to the parastyle. The metaloph is not joined to the ectoloph. There are ribs present on the external surface of the paracone and metacone. An external cingulum extends from the parastyle to the mesostyle but does not extend over the mesostyle. It then extends along the metacone and merges into the metastyle. The enamel is faintly rugose. The parastyle is strong.

A cheek tooth, either a P^4 or M^1, has no cingulum on the lingual face of the protocone. There is a trace of a cingulum between the protocone and the hypocone. A posterior cingulum extends from the posterior face of the hypocone to the metastyle. There is a strong connection of the hypostyle to the posterior cingulum by the lingual leg of the V. The apex of the V-shaped hypostyle joins the posterolabial corner of the hypocone. The parastyle is prominent and bulbous.

The lower incisors have sharp occlusal faces. The canines are large, flattened transversely and extend well above the occlusal plane of the incisors. The lower cheek teeth have anterior and posterior cinguli; a cingulum is present between the protoconid and the hypoconid. The metaconid and the mesostylid merge. There is no internal cingulum. The hypolophid merges with the entoconid. (Terminology from Osborn, 1918, p. 4.)

Discussion.---M^3 of UM 4035 is very close in size to that of the paratype of Miohippus gemmarosae (AMNH 13809) figured by Osborn (ibid., p. 67); however, AMNH 13809 does not have the internal cingulum developed on M^3 as in UM 4035, nor does the hypostyle of the M^3 of the paratype have the V-shape of the Peterson Creek specimen.

The lower cheek teeth of the Peterson Creek specimens are about 15% smaller than those of the paratype of M. gemmarosae (AMNH 12928). In the paratype there is greater development of the hypostylids and posterior cinguli. In the UM specimens the lingual valley between the parastylid and metaconid of M_1 is narrower than in the paratype of M. gemmarosae.

UM 4035 resembles M. gemmarosae in the size of the upper dentition, in the hypostyle joining the hypocone, and in the degree of separation of the metaconule from the hypocone, but differs in having an internal cingulum on M^3 and in having a V-shaped hypostyle.

Measurements in mm of greatest diameters of UM 4035, M^3, ap = anteroposterior length, tr = transverse width:

M^3	ap	15.53
	tr	19.32
P_4	tr	13.09
M_1	tr	11.10
P_{2-4}		45.24
M_{1-3}		50.63

Suborder CERATOMORPHA Wood, 1937

Family RHINOCEROTIDAE Owen, 1845

Gen. et sp. indet.

Referred material.---UM 4049, fragment of jaw with broken cheek teeth, from MV 7305.

Discussion.---A small rhinoceros is represented by a single jaw fragment, but not enough is present to make a generic designation. A lower cheek tooth measures 37 mm in length.

CONCLUSIONS

The Peterson Creek Local Fauna represents a stream bank community and the lithology of the beds is characteristic of a floodplain deposit. Volcanic rocks in stream channels originated from the Yearian Volcanics north of Peterson Creek and give further evidence that the Lemhi River has reversed its course. A period of erosion occurred between the eruption of the volcanics and the deposition of the Peterson Creek beds.

Two species of Meniscomys with a large difference in degree of hypsodonty show the rapid evolution of the genus and give an age equivalent of the Peterson Creek beds to the Meniscomys Concurrent-range Zone of the John Day Formation of Oregon.

The upper dentition of Niglarodon is similar to Meniscomys but has an incomplete anterior cingulum, greater crown height and proportionately longer anterior lobe on P^4. Its stratigraphic position places Niglarodon as a contemporary of Meniscomys.

Associated upper and lower dentition and skull fragments make possible a restoration of the skull and jaw of Promylagaulus lemhiensis, a new species larger than the type P. riggsi and more nearly like the later mylagaulids. The absence of the protofossette in the P^4 may preclude P. lemhiensis from the direct ancestry of the later mylagaulids. The unworn lower dentition is very like that of Meniscomys but increasing stages of wear greatly change the pattern and properties of the occlusal surface.

Entoptychus fieldsi and E. sheppardi are early entoptychines and are more primitive than E. basilaris of the John Day Formation of Oregon. Their primitiveness and stratigraphic position could indicate possible ancestry to the John Day entoptychines. Upper and lower juvenile dentitions confirm the identification of previously unassociated deciduous premolars.

The association of upper and lower dentitions of Paciculus insolitus establishes the validity of the taxon Cotimus alicae Black.

The occurrence of a large, a medium, and a small oreodont in the Peterson Creek beds is similar to that association in the Canyon Ferry beds of Montana.

A procyonid is one of the predators of the small mammals. Several skulls, jaws and limb bones of Entoptychus were found jumbled together in one small block. These fossils were relatively undamaged and may be the residue of fecal material of an owl.

Several species in common with the intermontane basins of Montana indicate a closer relationship of the Peterson Creek Local Fauna to the intermontane basins than to the John Day of Oregon or the Wounded Knee Fauna of South Dakota.

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TABLE 1

Measurements of dentition of *Meniscomys* and *Niglarodon*, ap anteroposterior length, tr transverse width measured at occlusal surface in mm unless otherwise noted

	UM 5099 *M. yeariani*	AM 6965 *M. hippodus****	UM 5101 *Niglarodon* sp.
I/ ap			2.28
tr		2.0****	2.07
P^3-M^3*		8.0****	11.43
P^3 ap**	1.72		1.98
tr**	1.56		1.60
P^4 ap	4.23	2.66	4.36
tr	3.68	2.43	3.81
M^1 ap	1.99	2.10	2.10
tr	2.98	2.35	3.13
M^2 ap	2.04	2.10	2.34
tr	2.98	1.92	3.04
M^3 ap		2.10	2.37
tr		1.76	2.55
P^3 to base of 2/		6.5****	ca 3.55
Transverse between P^3s*	2.72	2.0****	

TABLE 1 (continued)

	UM 5102 *M. yeariani*	AM 6965 *M. hippodus*	UM 5194 *M. petersoni*
P_4 ap	3.35	3.45	3.91
tr	2.00	2.31	2.32
M_1 ap		2.05	2.14
tr		1.93	2.04
M_2 ap		2.78	2.37
tr		1.95	2.48
M_3 ap		2.40	2.75
tr		1.76	1.98
P_4-M_3			11.30

* measured at alveolar level

** greatest length or width of crown

*** from McGrew, 1941

**** from Cope, 1884

TABLE 2

Measurements of dentition of Promylagaulus in mm, ap anteroposterior length, tr transverse width, measured on occlusal surface unless otherwise noted.

	Promylagaulus lemhiensis				Promylagaulus riggsi	
	UM 4038	UM 4039	ISU 18594	ISU 18601	FM P27256	AMNH 10824
I^1 ap*	3.19					
tr*	2.08					
P^4 ap	4.16	3.02			3.41	
tr	3.25	2.92		3.82	2.60	
M^1 ap	2.11			2.56	1.54	
tr	3.06			3.40	2.25	
M^2 ap	2.21			2.51	1.84	
tr	2.72			2.96	1.91	
M^3 ap				1.88	1.30	
tr				2.27	1.52	
P_4 ap			3.74			
tr			2.32			
M_1 ap			2.78		2.38	
tr			2.24		1.78	
M_2 ap			2.56		2.00	
tr			2.17		1.77	
M_3 ap			2.15		2.40	
tr			1.62		1.25	
P_4-M_3*			11.92			

* measured at alveolar level

TABLE 3

Measurements of skull, mandible and dentition of *Entoptychus fieldsi* in mm after Rensberger (1973, p. 90)

	UM 5191 Aged	UM 5192 Young
Length of upper cheek teeth	6.70	.....
Length of P^4	2.33	.....
Width of metaloph on P^4	2.50	.....
Length of M^1	1.60	.....
Width of protoloph on M^1	2.25	.....
Length of M^3	1.47	.....
Width of upper incisor	1.50	.....
A-P diameter of upper incisor	2.42	.....
Depth of skull	8.90	.....
Width of frontals between orbits	6.56	.....
Diastema I/to P^4	10.64	.....
Length of lower cheek teeth		7.60 ..
Length of P_4		2.10 ..
Width of metalophid on P_4		1.70 ..
Width of hypolophid on P_4		1.90 ..
Length of M_1		1.85 ..
Width of metalophid on M_1		2.15 ..
Width of hypolophid on M_1		2.15 ..
Width of lower incisor		1.45 ..
A-P diameter of lower incisor		1.95 ..
Depth of mandible from lingual enamel dentine border of M_1 parallel to central axis of tooth		5.30 ..

TABLE 4

Measurements of skull, mandible and dentition of *Entoptychus sheppardi* in mm after Rensberger (1973, p. 90)

	UM 5396 Juvenile	UM 5395 Young	UM 5395 Aged
Length of upper cheek teeth	7.00	7.60	7.00
Length of DP^4	2.25		
Width of metaloph of DP^4	2.20		
Length of P^4		2.35	2.45
Width of metaloph of P^4		2.80	2.70
Length of M^1	1.60	1.70	1.45
Width of protoloph of M^1	2.35	2.55	2.65
Length of M^3	1.40	1.45	1.35
Width of upper incisor	1.65	1.85	1.70
A-P diameter of upper incisor	2.05	2.45	2.40
Depth of skull		11.20	12.35
Width of frontals between orbits		6.70	6.05
Diastema /I to P^4		14.40	14.95

TABLE 4 (continued)

	UM 5399 Juvenile	UM 5400 Young	UM 5112 Aged
Length of lower cheek teeth	8.90	7.50	7.79
Length of DP_4	2.50		
Width of hypolophid of DP_4	1.60		
Length of P_4		2.25	2.44
Width of metalophid of P_4		2.00	1.85
Width of hypolophid of P_4		2.25	2.22
Length of M_1	1.60	1.55	1.82
Width of metalophid of M_1	2.30	2.10	2.37
Width of hypolophid of M_1	2.45	2.10	2.41
Width of lower incisor	1.40	1.60	1.88
A-P diameter of lower incisor	1.90	2.00	2.13
Depth of mandible*	4.65	5.20	6.98
Width of mandible**			4.41

*From lingual enamel dentine border of M_1 parallel to central axis of tooth.

**Through widest part of masseteric crest.

TABLE 5

Measurements of postcranial elements of Entoptychus sheppardi.

	UM 5112
Anteroposterior length of sacrum	23.43
Transverse width of proximal end of femur across widest parts of lesser trochanter and third trochanter	8.50
Length of femur	29.32
Transverse width of distal end of femur	7.26
Minimum transverse diameter of shaft of femur	3.18
Length of tibiofibula	30.18
Length distad of distal junction of fibula	11.56
Maximum transverse width of tibiofibula near distal end	6.14
Transverse width of tibiofibula at 8mm proximal of distal end.	2.82
Maximum breadth of tibia across lateral crest	5.80
Length of astragalus from posterior edge of lateral condyle to anterior extremity of head	5.59
Width of astragalus from posterior edge of lateral condyle to posterior edge of medial condyle	2.99
Anteroposterior length of calcaneum	8.99
Greatest width of calcaneum from sustentaculum to peroneal process	5.74
Anteroposterior diameter of navicular	3.64
Anteroposterior length of distal phalanx	4.26

TABLE 6

Measurements of dentition of Paciculus insolitus and P. montanus, ap anteroposterior length, tr transverse width, measured on greatest diameters in mm

	UM 5104	UM 5105	UM 5106	UM 5107	UM 5108	UM 5109	AMNH 7022**	YPM 14027*
	Paciculus insolitus						insol.	mont.
M^1 ap				2.22	2.16	2.21	2.32	2.3
tr				1.65	1.58	1.70	1.90	1.6
M^2 ap				1.63	1.66	1.75	1.94	1.75
tr				1.66	1.70	1.70	2.01	1.8
M^3 ap				1.39	1.34	1.17		
tr				1.34	1.40	1.40		
$M^1 - M^3$				5.18	5.03	5.18	5.65	
$\overline{I}$ ap	1.32	1.30	1.28					
tr	0.97	1.02	0.93					
M_1 ap	2.22	2.05	2.10					
tr	1.53	1.45	1.43					
M_2 ap	2.01	1.78	1.80					
tr	1.55	1.64	1.60					
M_3 ap	1.84	1.66						
tr	1.61	1.41						
$M_1 - M_3$	5.71	5.62						

* Black, 1961a, p. 12

** Wood, 1936, p. 6

TABLE 7

Measurements of skull, jaw and dentition of Megoreodon grandis, ap anteroposterior length, tr transverse width measured at greatest diameters in mm. (See Schultz and Falkenbach, 1968, p. 472, for definitions of measurements.)

	CM 990	UM 4026	UM 4027	UM 4025
Length (max. supraoccipital crest to incisors)	391	370	385	.....
Basal length	327	301	324	.....
Width (maximum)	189	212	210	.....
Width braincase (maximum)	73	79	80	.....
Width, interorbital (minimum)	83	(87)	.....	
Distance anterior rim of orbit to base of canine	171	151	149	.....
Distance anterior rim of orbit to supraoccipital crest	207	213	217	.....
Length of nasals	.....	183	.....	
Width muzzle at infraorbital foramina	89	69	83	72
Width across canines	71	(74)	(92)	81
Length C/- M^3 incl.	199	167	(186)	181
Length P^1-M^3 incl.	176	141	(185)	157
Length P^1-P^4 incl.	83	72	(74)	79
Length M^1-M^3 incl.	96	72	93	(80)
Width M^3	34	29	37	34
Depth malar below orbit	.....	50	44	.....
Length of jaw (maximum)	306	.....	.....	286
Length /C to condyle incl.	292	.....	.....	272

TABLE 7 (continued)

	CM 990	UM 4026	UM 4027	UM 4025
Depth jaw under coronoid.....	142	.....		143
Depth jaw below ant. lobe M_3.....	56	.....		57
Length /C-M_3.....	204	.....		182
Length P_1-M_3.....	191	.....		166
Length P_1-P_4.....	90	.....		79
Length M_1-M_3.....	103	.....		89

TABLE 8

Measurements of skull, jaw and dentition of Mesoreodon in mm. Parentheses denote approximations. (Schultz and Falkenbach, 1968, p. 472 for definitions of measurements).

	M. chelonyx UM 4029	M. chelonyx PU 10425	M. ? latidens CM 903	M. wheeleri YPM 13950
Basal length (from anterior notch of foramen magnum to base of I.....	(235)	(215)	217.5	239
Width (maximum).....	(150)	(131)	140	167
Distance from anterior rim of orbit to base of canine.....	(116)	97	.....	104.5
Width across upper canines (max.)....	50	(45)	.....	(52)
Width of palate between P^4s.....	39	.....	.....	41
Width of palate between canines.....	27.5	(24)	.....	(30)
Length C/ - M^3 incl.	130.5	117	125	(134.5)
Length P^1 - M^3 incl.	114	.....	.....	116
Length P^1 - P^4 incl.	54	.....	50	57.5
Length M^1 - M^3 incl.	62	56.5	60	61.5
Depth of malar below orbit.....	25.5	.....	22	23.5
Length of jaw (max. incl. incisors)..	(208)	(188)	180	(204)*
Depth of jaw under coronoid.....	120.5	89	.....	106*
Depth of jaw under ant. end of M_3....	44	36	.....	41.5*
Length /C to condyle incl.	190	(175)	.....	(184)*
Length P_1 - M_3 incl.	123	108	.....	.....
Length P_1 - M_4 incl.	58	49	50	.....
Length M_1 - M_3 incl.	68.5	59	65	63.5*

* AMNH 45423 referred to M. chelonyx wheeleri

PLATE 1

1. Domnina sp., UM 4042, labial view of right ramus with M_2, stereo pair. Scale = 0.5 mm.
2. Same, occlusal view, stereo pair. Scale same as 1.
3. Sciurid, UM 4054, occlusal view lower M_2 or M_3. Scale = 0.5 mm.
4. Sciurid, UM 4043, occlusal view lower M_2 or M_3. Scale = 0.5 mm.
5. Promylagaulus lemhiensis, UM 5193, lateral view of cranium with M^1 - M^3, M_2 - $_3$. Scale = 2 mm.
6. P. lemhiensis, UM 5285, lateral view of rostrum with P^3 - M^3, reversed. Scale = 2 mm.
7. P. lemhiensis, UM 4038, left P^3 - M^2, stereo pair. Scale = 1 mm.
8. P. lemhiensis, ISU 18594, right ramus with P_4 - M_3, stereo pair. Scale = 1 mm.
9. P. lemhiensis, ISU 18601, left P_4, stereo pair. Scale = 1 mm.
10. P. lemhiensis, ISU 18601, right M^3, stereo pair. Scale = 0.5 mm.

PLATE 1

PLATE 2

1. Niglarodon sp., UM 5101, lateral view of skull. Scale = 2 mm.
2. Same, ventral view. Scale = 2 mm.
3. Same, occlusal view upper cheek teeth, stereo pair. Scale = 1 mm.
4. Oreolagus sp., UM 4060, occlusal view lower cheek tooth, stereo pair. Scale = 0.5 mm.
5. Meniscomys yeariani, UM 5099, occlusal view of upper cheek teeth, RP^3 - M^2, LP^3 - M^1, stereo pair. Scale = 0.5 mm.
6. M. yeariani, UM 5102, left P_4, stereo pair. Scale = 0.5 mm.
7. M. petersoni, UM 5194, occlusal view left ramus with P_4 - M_3, stereo pair. Scale = 0.5 mm.
8. M. yeariani, UM 4040, left P_4, stereo pair. Scale = 0.5 mm.

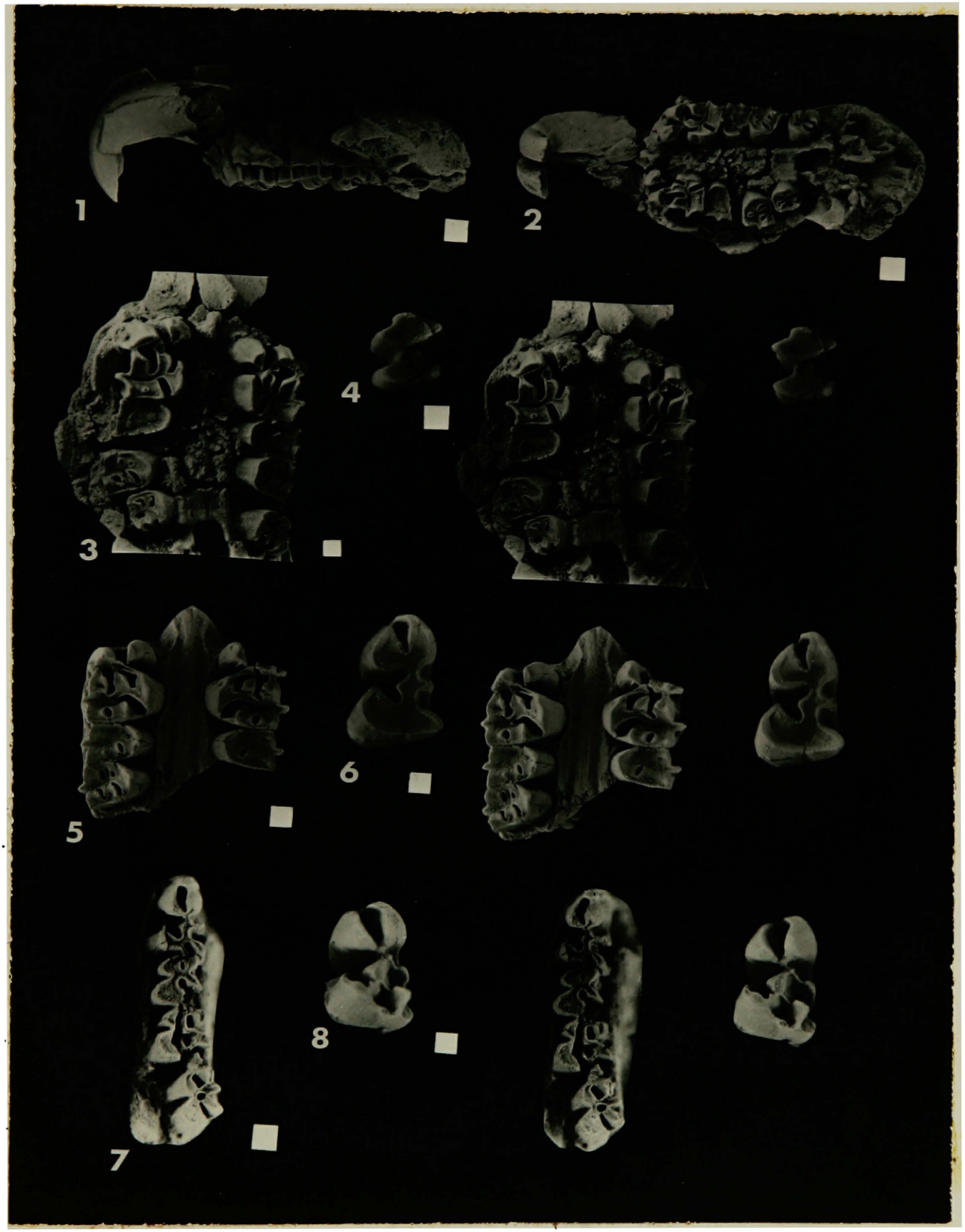

PLATE 2

PLATE 3

1. Entoptychus sheppardi, UM 5194, lateral view of skull. Scale = 2 mm.
2. E. sheppardi, UM 5112, medial view left jaw. Scale = 2 mm.
3. Same, lateral view. Scale = 2 mm.
4. E. sheppardi, UM 5112, lateral view M_3. Scale = 0.5 mm.
5. E. sheppardi, UM 5194, dorsal view of skull. Scale same as 1.
6. Same, ventral view. Scale same as 1.
7. E. sheppardi, UM 5111, occlusal view broken rami with LP_4 (brkn) - M_3, RM_{1-3}, anterior down. Scale = 1 mm.
8. E. sheppardi, UM 5112, occlusal view left ramus with P_4 - M_3, stereo pair. Scale = 1 mm.
9. E. sheppardi, UM 5411, anterior view, distal portion left humerus. Scale = 2 mm.
10. E. sheppardi, UM 5412, anterior view, fragment of distal portion of right humerus. Scale same as 9.

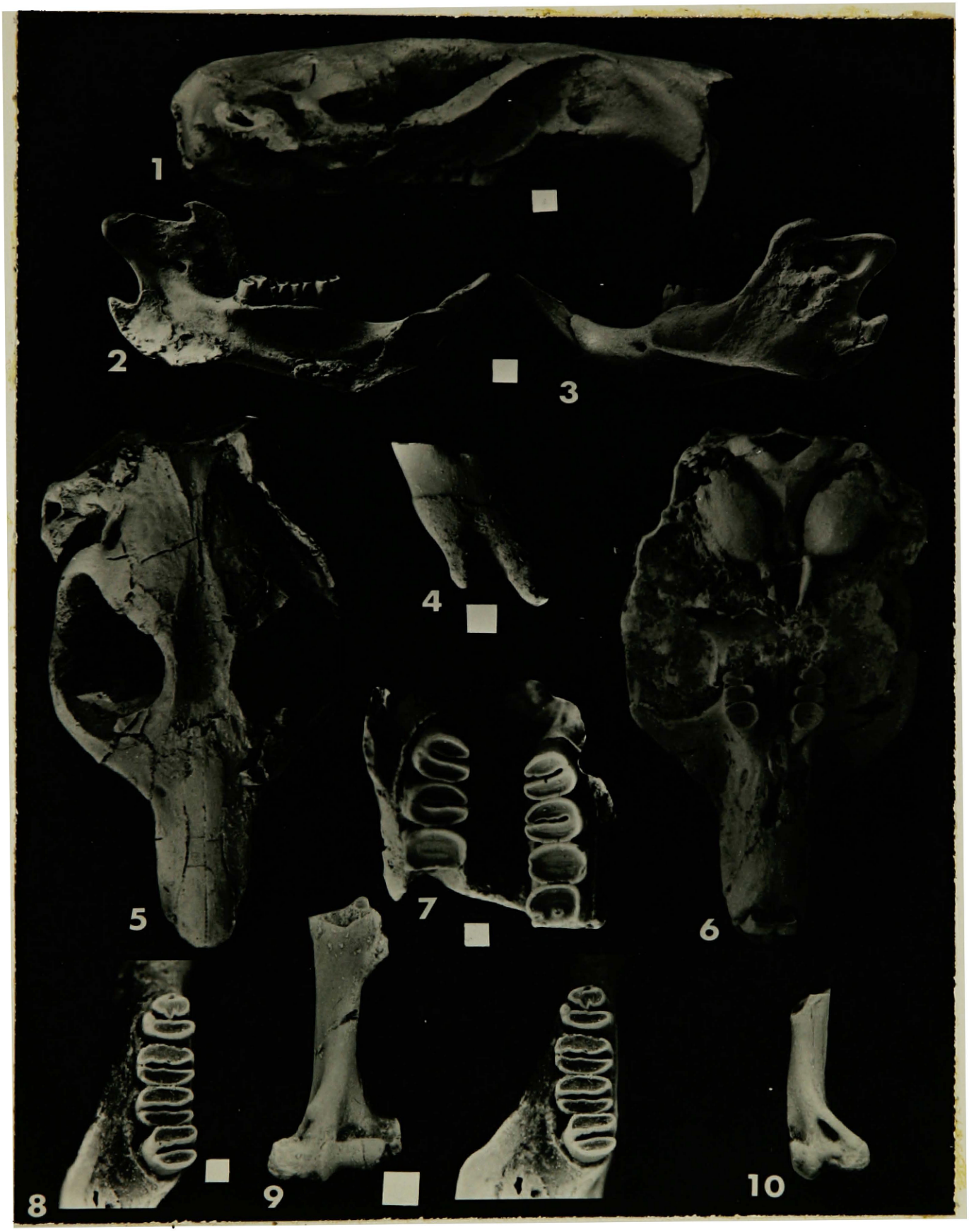

PLATE 3

PLATE 4

1. Entoptychus sheppardi, UM 5397, occlusal view left DP^4 - M^3, stereo pair. Scale = 1 mm.
2. E. sheppardi, UM 5399, occlusal view right DP_4 - M_3, stereo pair. Scale = 1 mm.
3. E. sheppardi, UM 5395, occlusal view right P^4 - M^3, stereo pair. Scale = 1 mm.
4. E. sheppardi, UM 5400, occlusal view left P_4 - M_3, stereo pair. Scale = 1 mm.

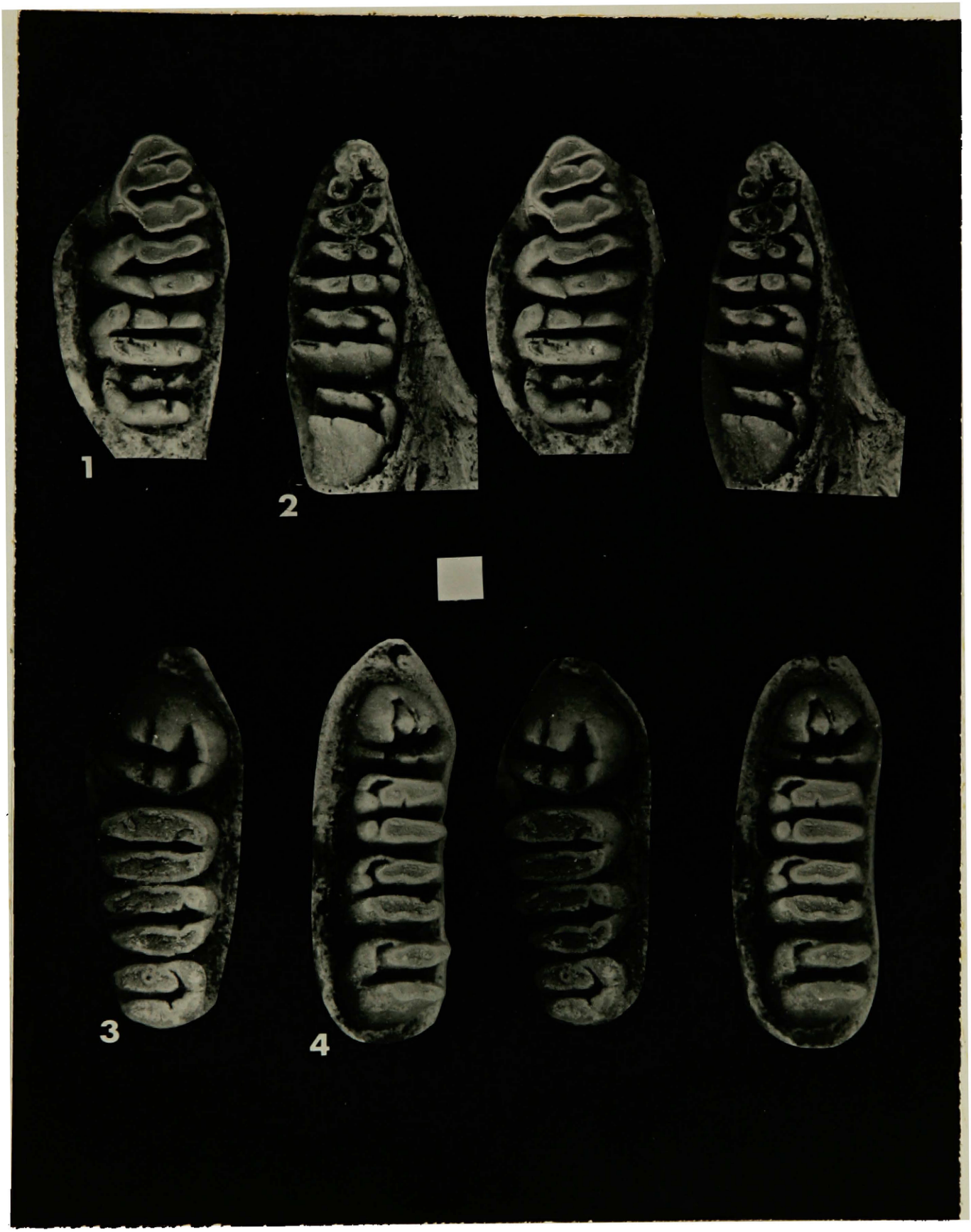

PLATE 4

PLATE 5

1. Entoptychus sheppardi, UM 5112, lateral view of right pelvis. Scale = 2 mm.
2. Same, anterior view of right femur. Scale = 2 mm.
3. Same, lateral view of right femur. Scale same as 2.
4. Same, posterior view of right femur. Scale same as 2.
5. Same, anterior view of left tibiofibula (reversed). Scale = 2 mm.
6. Same, lateral view of left tibiofibula (reversed). Scale same as 5.
7. Same, posterior view of left tibiofibula (reversed). Scale same as 5.
8. Same, dorsal view of left navicular. Scale = 1 mm.
9. Same, lateral view of distal phalanx. Scale = 1 mm.
10. Same, dorsal view of left astragalus. Scale = 1 mm.
11. Same, ventral view of left astragalus. Scale = 1 mm.
12. Same, dorsal view of left calcaneum. Scale = 1 mm.

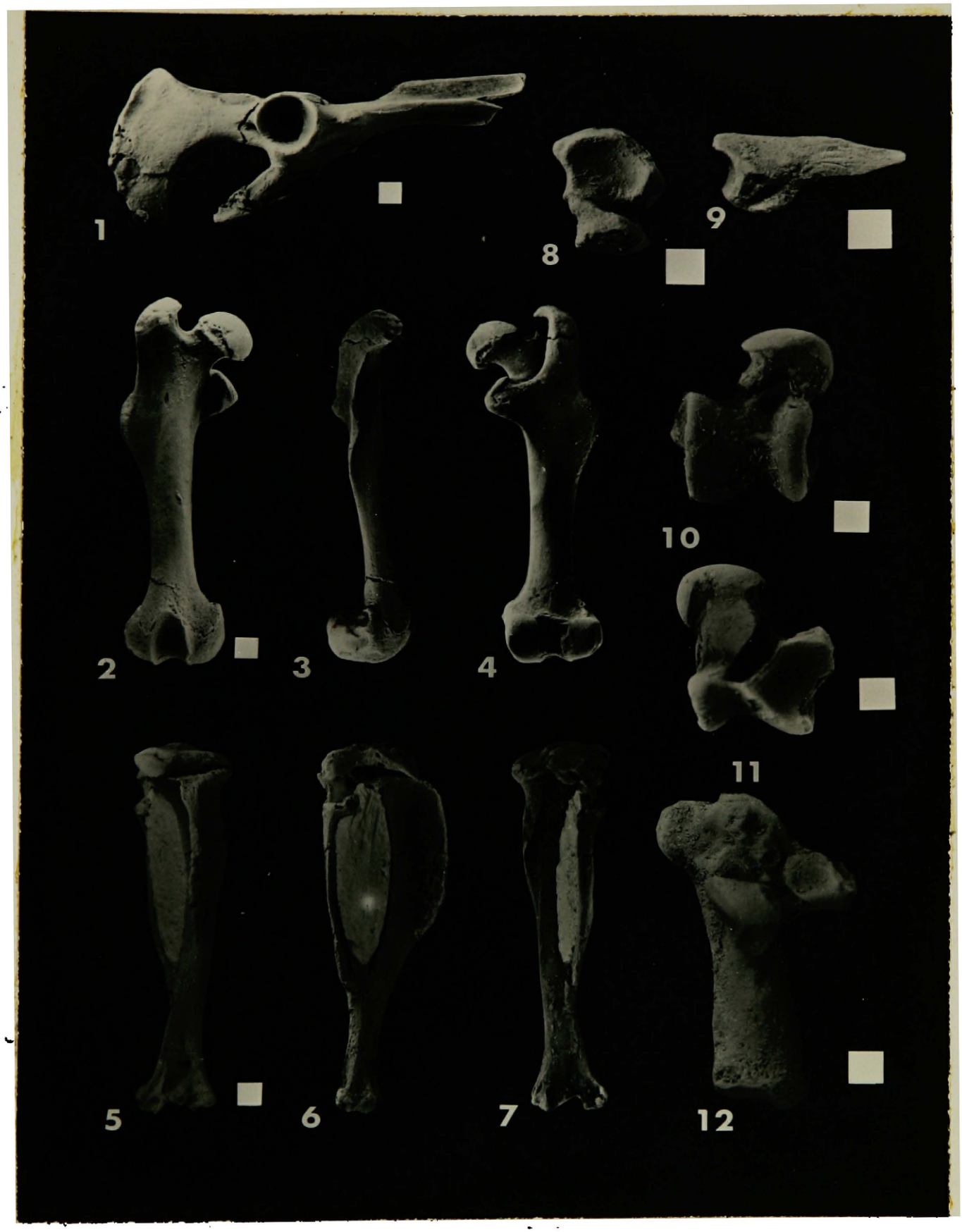

PLATE 5

PLATE 6

1. Entoptychus fieldsi, UM 5191, lateral view of skull. Scale = 2 mm.

2. Same, ventral view of skull. Scale same as 1.

3. Same, dorsal view of skull. Scale same as 1.

4. E. fieldsi, UM 5192, occlusal view, left P_4 - M_1, stereo pair. Scale = 0.5 mm.

5. Paciculus insolitus, UM 5106, lateral view of right ramus with /I M_{1-3}. Scale = 1 mm.

6. P. insolitus, UM 5109, lateral view of left maxilla with M^{1-3}, anterior to the left. Scale = 1 mm.

7. P. insolitus, UM 5109, occlusal view of left maxilla with M^{1-3}, stereo pair. Scale = 1 mm.

8. P. insolitus, UM 5106, occlusal view of right ramus with M_{1-3}, stereo pair. Scale = 1 mm.

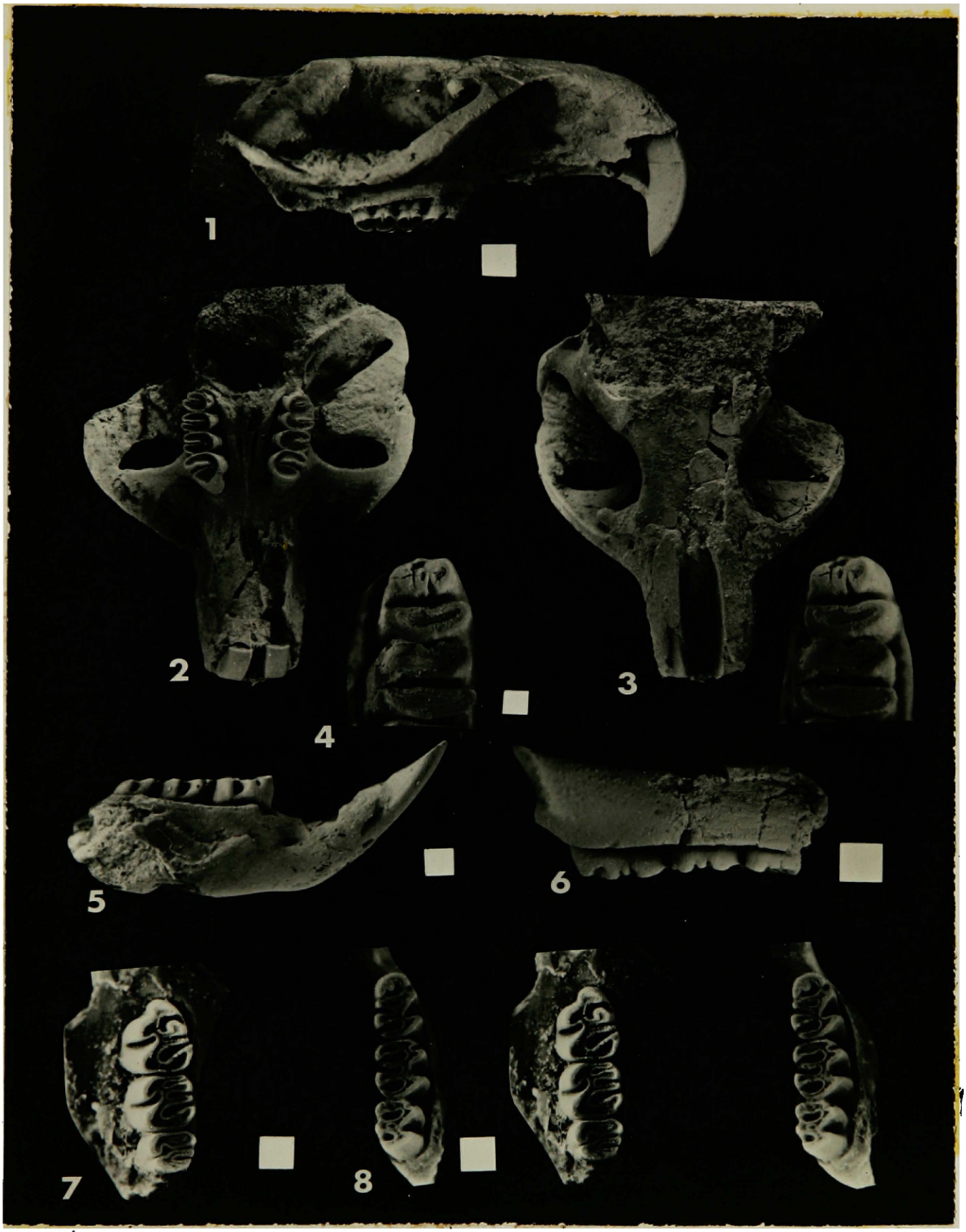

PLATE 6

PLATE 7

1. Megoreodon grandis, UM 4026, dorsal view of skull. Scale = 2 cm.
2. Same, ventral view of skull. Scale same as 1.
3. Same, lateral view of skull. Scale same as 1.
4. Megoreodon grandis, UM 4025, lateral view of right jaw (reversed). Scale same as 1.
5. Mesoreodon chelonyx, UM 4029, lateral view of jaw. Scale = 2 cm.
6. Miohippus cf. gemmarosae, UM 4035, upper M^3. Scale = 4 mm.
7. M. cf. gemmarosae, UM 4035, UM 4035, lower M_3. Scale = 4 mm.
8. M. cf. gemmarosae, UM 4035, lateral view of jaw. Scale = 1 cm.

PLATE 7